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MINING MACHINERY

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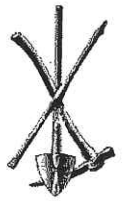
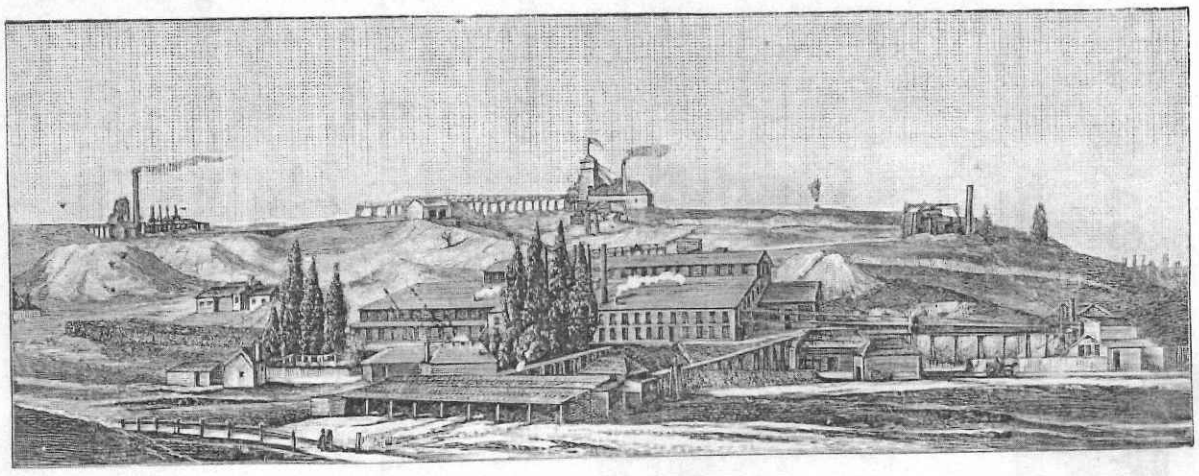
MINING MACHINERY.



General View of the Port Phillip and Colonial Gold Mining Company's Works, Australia.



These works employ 80 head of stamps, with their usual accessories for concentration and amalgamation, and up to 1880 had produced gold to the value of nearly £2,000,000 sterling, the quantity of quartz raised and crushed being about 1,123,000 tons.

MINING MACHINERY:

WITH

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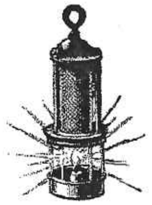

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MINING MACHINERY.

IT is not our intention, in this Catalogue, to enter into the details of the geology or metallurgy of mining, as these subjects would be far beyond the scope of a book of this character, the subject having already been so ably treated upon by Percy, Phillips. Lock, Egbaston, &c., &c.

We shall, therefore, only indicate briefly the chief systems in use for the getting, reducing, concentrating, and amalgamating gold and silver ores, together with the most general forms of machinery and plant employed, giving, where practical, the data as to prices, weights, power, and production within a given time, so as to enable intending purchasers, at a distance, to generally understand the nature and construction and method of working of each process or machine, together with its approximate cost, and, to further facilitate this, we have annexed complete estimates for several sizes of mills, with the stores, &c., usual to be furnished with them; and we have further endeavoured to codify the whole of these price lists, &c., so that, in the event of any machine or parts being required, they can be telegraphed for and can be supplied with the least possible delay. We desire it, however, to be distinctly borne in mind that the prices are given approximately, and that it is always desirable to obtain quotations by correspondence from particulars to be supplied. A key to this code, with examples, will be furnished on application.

It will be assumed that the users of this book are tolerably conversant with the general routine of mining, reduction, and the treatment of the sulphurets, but, as it may fall into the hands of persons unacquainted with these processes, we will briefly recapitulate them.

The usual treatment of gold ore is by amalgamation, concentration, roasting, and chlorination.

The **Amalgamation** was formerly conducted by the "Arastra," which consisted of a masonry circular floor of a diameter of 10 to 20 ft., having a curb of wood on its outer edge some 2 ft. high, and a central shaft with two or more horizontal arms, to which were attached edge runners or mullers of granite. The ore, being previously broken into small pieces by rollers or crushers, is put over this floor, and the edge stones revolved at a speed of about 7 ft. per second over the ore, quicksilver being added from time to time as the reduction proceeds, and when this reduction and amalgamation is completed, the "slime," or "gangue," is washed off and the amalgam "cleaned up," as it is technically termed, to be afterwards squeezed and retorted. This system is, however, very antiquated, and is superseded by the process of "panning," which consists in first crushing the ore by rollers or Blake's crusher, next reducing by wet stamp mill to a fine granular state and running into receiving tanks, charges of which,

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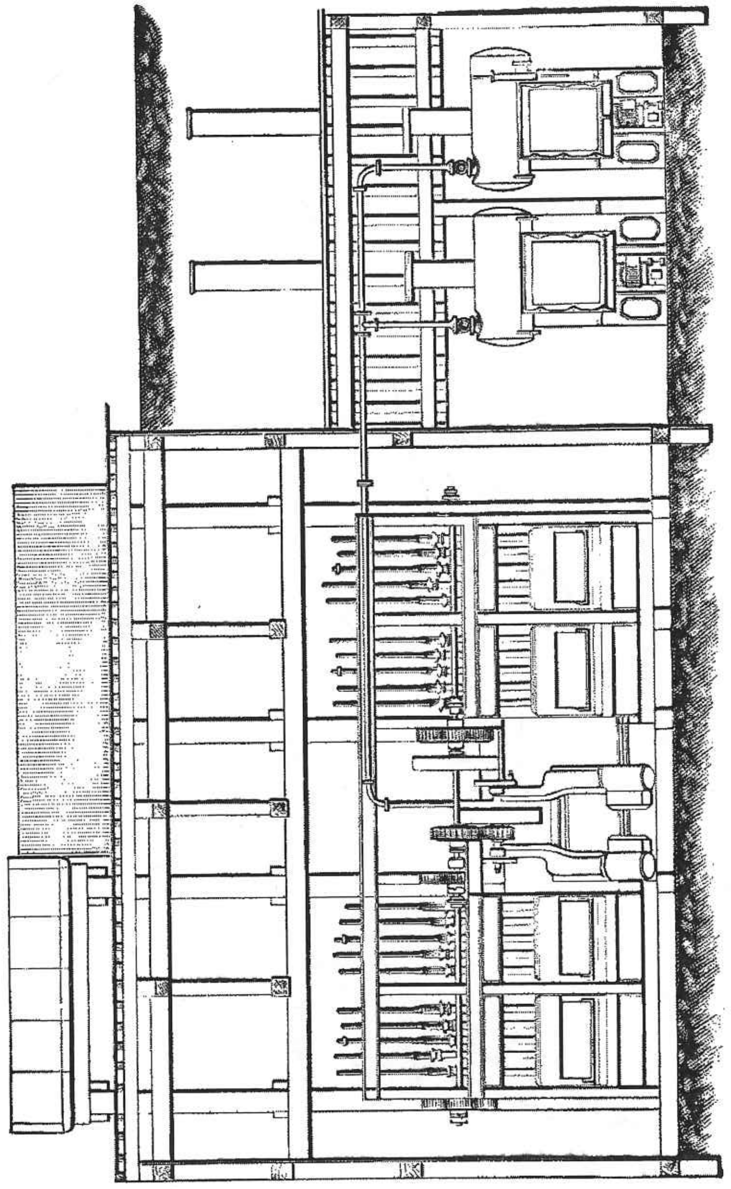
with water added, are thoroughly ground in iron pans, and as the gold exists in the ore in a metallic state, friction with moderate heat is sufficient for its amalgamation. This heat is usually given to the pan by a steam-jacketted bottom, into which live or exhaust steam is introduced ; excessive heat, however, has been found to be detrimental to amalgamation. The quicksilver is added to the pulp when the pan is set running, but with the muller raised until the ore is somewhat reduced, after which the muller is brought down to its proper position ; this is done to avoid grinding the quicksilver unnecessarily. In some cases the richer portions of ore are concentrated by blankets, percussion tables, "Frue Vanners," or other machinery, and then pulverized and amalgamated in pans.

Amalgamation is sometimes commenced directly in the mortars of the stamp mill, and then carried over copper tables or plates, riffles, and mercury boxes or baths, and the tailings afterwards treated by pans, the grinding and amalgamation being effected continuously. The sulphurets are treated (if sufficiently rich) by roasting, then ground and amalgamated. It is usual, before roasting, to expose the sulphurets for a considerable time to the atmosphere, with a sprinkling of common salt to thoroughly oxidize them.

Chlorination.—This system is as follows : The pulverized ores, after being well roasted, cooled, and moistened by water, are put into close vessels with false bottoms, into which chlorine gas—generated by heating sulphuric acid, peroxide of manganese, and common salt, in a leaden generator—is introduced The gas, being conveyed through leaden pipes into the bottom of the vessels, should be first forced through clean water to free it from muriatic acid, which is detrimental to this operation. The effect of the gas is to produce trichloride of gold. After the chlorine gas has done its duty, pure water is added to the ore, which dissolves the trichloride of gold, and the solution is drawn off and treated with a solution of sulphate of iron to precipitate the gold, which can then be collected and melted.

The construction of gold mills is of far greater variety than silver mills—although the same machines in both processes are employed, namely, the breaker, stamps, grinders, amalgamators, and concentrators. The silver mill is subject to a greater diversity of arrangement than the gold mill. If gold is very fine and equally diffused in the ore the same machinery as used for treating silver ore will suit it admirably, but if the gold in the ore is coarse and free, grinders, amalgamators, &c., may be dispensed with, the crusher, or breaker, stamps and copper tables, with riffles, being then all that is necessary. But no absolute rule can be laid down, the nature of the treatment must be determined by the character of the ore. If, for instance, the ore contains sulphurets, concentrators and amalgamators will be necessary to treat the stuff directly after the stamps.



ELEVATION OF TWENTY-HEAD MILL.

Fig. 1.

SECTION OF TWENTY-HEAD MILL.

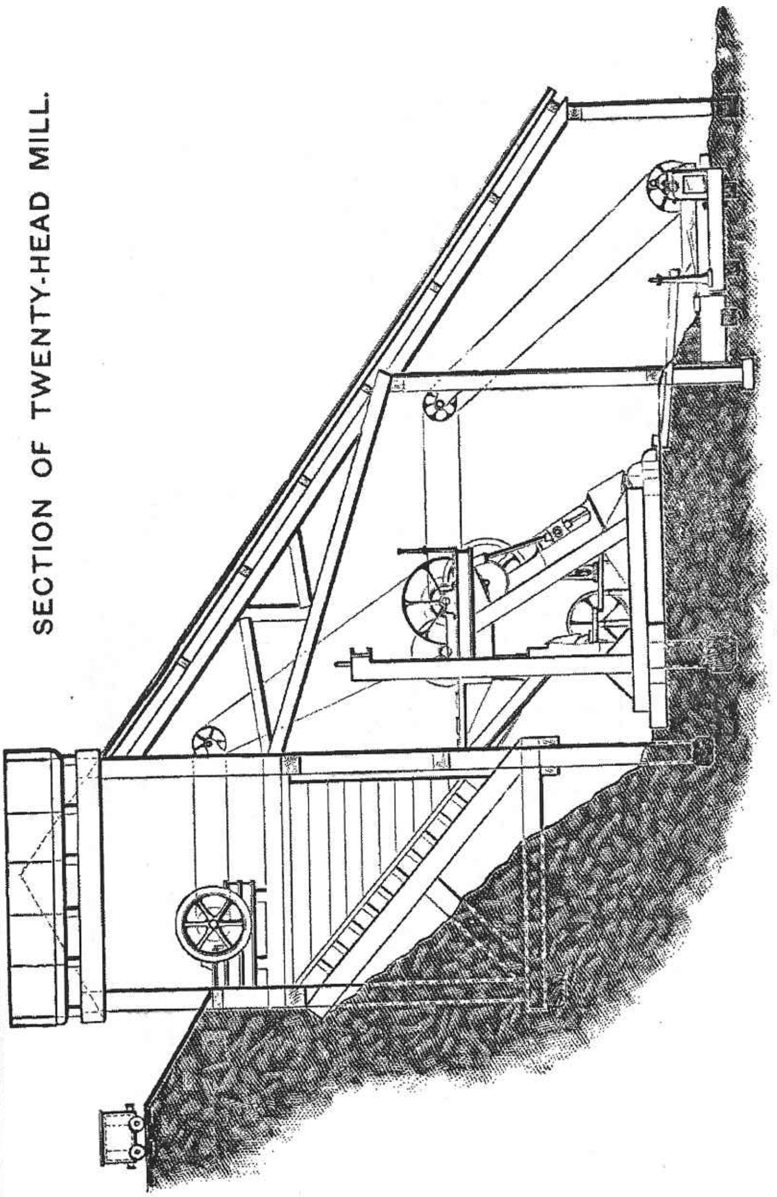


Fig. 2.

Much diversity of opinion has, from time to time, arisen as to *wet* or *dry* stamping, and with or without mercury in the stamp mortar; but the weight of practice is much in favour of the wet process, and without the mercury in the mortar, as the addition of quicksilver into the battery requires considerable care and attention. The *dry* process requires the ore when crushed to be dried, sized, or classified, after which it requires treatment exactly the same as the *wet*; and although it is affirmed that a slightly greater yield of gold can be obtained by the *dry* than the *wet* process, the extra cost of working, wear and tear of plant, and its injurious effect upon the health of the operator, has caused the latter to be now almost universally adopted.

Although to maintain a proper sequence in describing the mining machinery in detail, many things should properly come before a complete mill, yet we propose to illustrate and describe these first, as being the most important, and as better opening up the whole subject.

Figures 1 and 2 illustrate a gold mill of the most modern type, designed under the direction of C. J. Harvey, Esq., formerly of Victoria, but now Mining Engineer for the Essaman Gold Mining Company (West Coast of Africa),—this gentleman having had a large and varied experience in all parts of the world, he being the first to introduce the use of iron and steel framing, steel mortars, steel cams, discs, shoes, anvils, &c.; and, although, when the iron frames, &c., were first introduced by him, many mining engineers were of opinion that iron framings would never withstand the vibration to which this class of machinery is subjected, they have, nevertheless, been universally adopted.

The mill (Figures 1 and 2) consists of twenty head of stamps, and comprises the following machinery, stores, and outfit:—

One Blake's system ore breaker.
Twenty head of stamps, in wrought-iron frames.
Amalgamating electro-plated copper plates and riffles.
Mercury boxes—Halley's concentrating tables.
30-H.P. nominal engine, compound, condensing.
Two 30-H.P. improved tubular boilers.
Shafting, gearing, straps, pulleys, &c.
Duplex steam pump, water tank, pipes, &c.

This mill may be taken as a general arrangement usual for a gold mill working a free gold ore, and in which no special appliances for concentrating and amalgamating are required. The ore breaker is of the most powerful kind, steel being freely introduced into its construction, the frame being of wrought iron. The size of the machine being 16 in. × 8 in. in the jaws, the crushed materials fall from this into a storage hopper, so that if the mill is running continuously, day and night, the ore breaker being of ample power need be run only during the day. This storage hopper commands the various feed shoots, which are automatic in their action, and deliver the crushed ore into the mortars. These mortars are of *cast crucible steel*, in one casting; each containing five head of stamps, and each head having a falling weight of 850 lbs. These mortars are of a most improved design, and have front or single discharge grates, this arrangement being best suited to the particular mill, but the mortars can be made with single or double discharge grates if desired. The discharge opening is divided into two, and the grate plates are of steel, perforated, 120 holes to the inch, fitted into a rebate, and held in position by a steel frame with hinged bolts and lock nuts, a washer of felt being interposed between the screen and frame; the anvils and shoes are of steel, the heads of cast iron, with double wrought-iron hoops; the shanks or lifters are of steel, fitting into the heads with a bored and turned taper "fitting," all of which are done to accurate gauges, and are interchangeable. The upper parts of the lifters are screwed with a special thread to take the lifting discs and lock nuts, which are also of steel. The tops of the mortar are fitted with hard wood covers, which also serve as a vertical bearing to the shank close down to its work. These covers are in halves, easily removable or renewable; each shank has also two cast-iron bearings of great length, the lower ones fitted with double bolts. These lower bearings are fitted with gun-metal dies and wing screws, and will hold up any of the stamps at pleasure; the cams are of the best form of cast steel, arranged to give the usual sequence of drop. These cams are double armed, bored and keyed by sunk steel keys on to a 5-in. diameter steel shaft; this shaft is fitted into gun-metal bearings of at least one and a half diameters in length, double bolts to each cap, lock nuts and split pins. The cam shafts are independent for each five head, and are driven from a 4-in. diameter steel countershaft, making 80 revolutions per minute, and spur gearing, the teeth of which are lined up to their pitch lines, the pinions having clutches with diagonal teeth, these being also lined or shrouded up to the half depth of the clutch tooth to give them increased strength. Each of the sliding clutches has two feathers, shaped out of the solid metal of the shaft, and they are fitted with levers and quadrant plates that can be easily handled from the front platform by the millman, to stop and start any five head of stamps while the mill is running. This shaft is also fitted with wide gun-metal bearings, with ample provision made for lubrication; the centre shank is fitted with a tappet to give motion to the automatic feeding shoot. All the shanks are drilled with a hole at the top for slinging them by, a screw clip is also provided for the same purpose, which will be found very useful for slinging the shank and head out—an overhead running block, or "crawl," as it is termed in America and the Colonies, working on a beam fixed over the stamps,—and a set of 10 cwt. patent blocks makes the operation of changing the head a perfectly simple and expeditious one to a single man.

The frames, as before mentioned, are of wrought iron or steel, built up to the form shown with double bars of channel section with gusset plates between them, all the meeting joints being machined, and all holes drilled and fitted with turned bolts, the bolts being a driving fit, and the ends of the bolts are usually rivetted over slightly when finally erected. This will often save the difficulty of employing a set of rivetters, should such labour be difficult to obtain, but in all cases rivets are supplied in addition to the bolts, so that the rivets can be used if desired.

It will be noted that the central bay of the frame is designed to carry the pair of diagonal compound condensing engines, and is specially strengthened and designed for this duty, thereby dispensing with the use of driving straps or ropes or similar means of transmission, at the same time enabling the whole to be properly geared and fitted before leaving the works, and saving the whole cost and time that would otherwise be incurred in having to put down masonry or other foundations, items of considerable importance in many places.

The engines have cylinders of 10 in. and 20 in. diameter by 24 in. stroke; the high-pressure cylinder is steam jacketted, and fitted with expansion gear, worked direct from the governors; there is a provision for admitting steam into the low-pressure cylinder when starting the engines. Under the engines and between the frames a cylindrical surface condenser is placed, and as an ample supply of water is of necessity always available for the use of the stamps, advantage is taken of this, and the water passed through the surface condenser on its way to the storage tank, which may often be with advantage placed as shown in our engraving, or in any other place. The air-pump is worked from the cross head of the low-pressure cylinder—this arrangement will effect a saving of fuel of some 25 to 30 per cent. at the cost of but a few pounds extra.

The engines are of 30-H.P. nominal, and will work up to 100 H.P. actual, giving, at this power, very economical results. They are throughout of the very highest class design, special regard having been given to large area of bearing surface in the guides and bearings, taking up wear, lubrication, &c.

The engines receive their steam at 100 lbs. pressure from two boilers of the "Root" type, but greatly improved in all their details of construction, amongst which may be mentioned the discarding of the joint rings formerly used in this class of boiler and substituting conical metal-to-metal joints for the connection of the tubes; the raising of the water line to the top of the tubes, thus giving additional heating surface, and using a very large steam receiver fixed on the top of the boiler casing; hinged clearing doors in the casing; and many other improvements in detail suggested by experience.

The boilers are replete with every fitting of the best class, including a duplex steam feed-pump, "Fielding's patent," which is silent in action and thoroughly reliable. The boilers are coupled together so that either can be worked independently of the other, and ample power is provided for driving the engines under easy firing with inferior fuel, and for supplying steam to the pumps for the general water supply if such should be required.

Where transport is difficult, this form of boiler offers great advantages; it is also more readily repaired than any other, spare parts, that can be replaced by any ordinary fitter or engine-man, being generally sent out with each boiler.

The mill countershaft carries the pulleys for driving the ore crusher and for driving the countershaft for the concentrators.

Reverting back again to the stamps—the mortars are fitted with hinged wrought-iron aprons over the screens or grate plates, and a lip is cast to the mortars that delivers the stamped material into distributing troughs or boxes having perforated bottoms; these troughs are fixed directly over the first electro-plated table, there being three in a set to each grate or port. These plates are made from ⅛-in. refined copper, planished, and coated with silver, 2 ozs. to the foot; they are mounted on pitch pine beds, 3 in, thick, made from narrow strips with the grain reversed, grooved and tongued together, and bolted right through to make a good level plane or bed, to which the plates are secured by outside flanges; the screw-holes are slotted to admit of a slight expansion or contraction of the timber bed without buckling the copper plates. The last two of each set of plates have riffles formed in the lower edge. The lower plates of each set deliver into a mercury box of cast iron with the inner surface enamelled; these are each fitted with iron screw-seated plugs, and are all connected together by an iron pipe of 2-in. diameter, which draws off the amalgam at each end of the battery. Two of these mercury boxes are placed in each set, No. 1 delivering into No. 2; this, in turn, delivers the tailings on to a Halley's patent percussion table or concentrator. This invention was first introduced into the mills of Australia with great success, and is now used in all parts of the world. It consists of a table of about 7 ft. long × 3 ft. 6 in. wide, the bed forming two slightly-inclined planes; a reciprocating motion is given to this table, it being suspended in four iron slings by means of a pair of cams, each with three teeth, a spring or springs keeping the table buffer up to its buffer-beam, except when the cams withdraw it; it will, therefore, be seen that at each revolution of the cams the table will make three oscillations, equal to the pitch of the cams, while the springs will bring it back against the buffer-beam with an equal number of smart blows or percussions, causing the light or waste portions of the ore to ascend the incline, while the sulphurets, or pyrites, collected or concentrated in the hollows or depressions of the table, are from time to time removed while the tables are in motion. The tailings passing from these tables can be next taken over

blankets, or, if found not of sufficient richness to warrant this, they are carried into a launder to waste. One of these percussion tables is required to every five head of stamps, and 1 H.P. is required for each table.

It is usual to send out with a twenty-head mill of the kind described the following duplicates and stores:—

DUPLICATES.

20 steel anvils or dies.
20 steel shoes.
5 steel cams.
20 steel lifting discs or tappets.
5 steel lock nuts.
20 spare Russian iron or steel screens.
2 spare countershaft brasses.
12 spare boiler tubes.
1 set crank shaft brasses.
1 spare pair eccentric straps.
1 pair of connecting rod brasses.
5 heads, hooped and fitted.
5 lifters or shanks.
1 complete set of crusher plates.
2 spare sets of fire bars.
2 doz. gauge glasses and rings.
2 spare cam shaft brasses.
1 set piston rings.
12 spare tube connectors.
1 set of donkey-pump valves.

STORES AND TOOLS.

1 large-sized portable forge.
1 2-cwt. anvil.
1 small outfit of smith's tools.
1 sledge hammer.
1 7-lb. flogging hammer.
2 hand hammers.
2 rivetting hammers.
2 rivet snaps.
2 pairs of stocks, dies and taps. (Whitworth thread.)
2 pairs of stocks, dies and taps. (Gas thread.)
1 14-in. ratchet brace and drills.
6 files each of 10 in., 12 in. and 14 in., round, half round, flat and square, with 1 doz. handles
1 set of 5-ton blocks.
1 set of patent pipe tongs.
1 set of steel spanners, ⅜ in. to 1½ in.
1 patent shifting spanner.
1 doz. best cast-steel chisels, chipping cross cuts, drifts and punches, assorted.
1 screw jack (4 tons).
2 crowbars.
1 5-in. best parallel vice.
1 36-in. grindstone, with spindle and carriage.
2 oil feeders, and
5-gall. can of lard oil,
5 ,, ,, common oil.
1 set of 1-ton patent blocks.
1 snatch block.
400 ft. of 3-in. cir. manilla rope.
1 small set of carpenter's tools, comprising—hand saw, planes, augers, &c., in box.
1 ton of hoop and bar iron, assorted.
5 cwt. of thick iron, assorted.
5 ,, best tool steel, assorted.
14 lbs. patent packing to suit the various glands.
28 lbs. of spun yarn.
28 lbs. tarred marlin.
28 lbs. of patent white metal.

TWELVE-HEAD BATTERY GRAVITATION STAMPS.

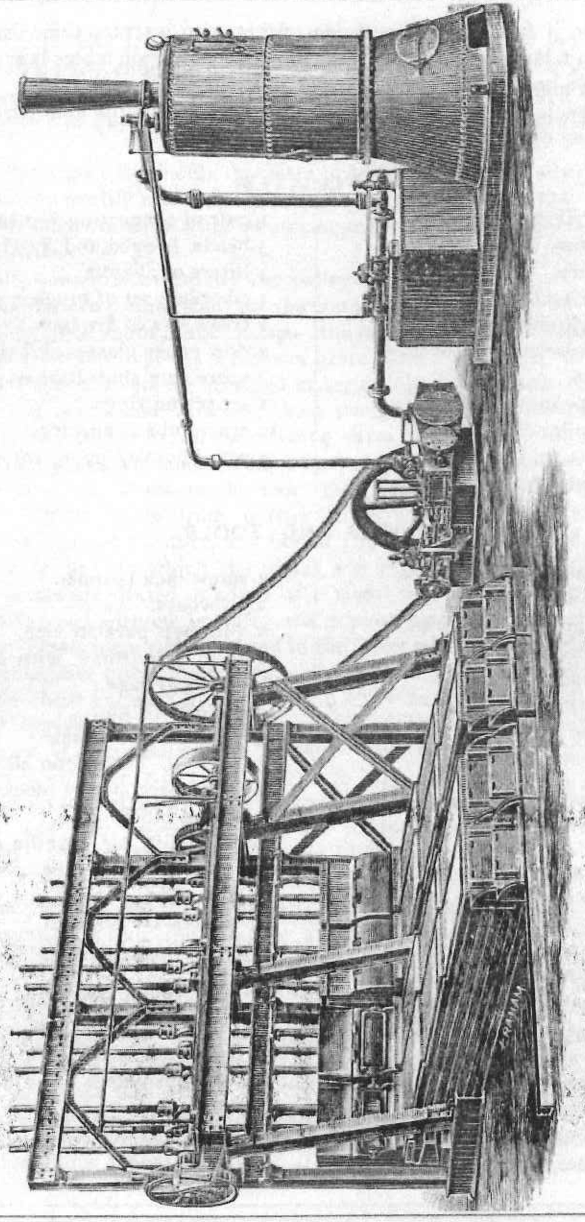


FIG. 3.

STORES AND TOOLS—*continued.*

2 ladles.
5 lbs. sal ammoniac.
5 lbs. spirit of salts.
5 lbs. of borax.
2 cramps.
2 pairs hand shears.
2 pairs plyers.
6 shovels.
6 picks, with handles.
6 axes.
2 band punches.
14 lbs. white lead.
14 lbs. red lead.
1 cwt. washers, assorted.
1 ,, tapped nuts, assorted.
1 ,, cotton waste.
50 ft. of gas or steam tube each—⅜ in., ½ in., ¾ in., 1 in., 1¼ in., 1½ in., 2 in., with 6 bends, tees, elbows, and lock nuts.
14 lbs. solder.
1 soldering bit or iron.
2 pairs of chain slings.
5 lbs. of resin.
2 lbs. of spelter.

The duplex pump is of the type shown at Figure 54, page 71, constructed on Fielding's patent, and is provided to give an ample supply of water to the twenty head of stamps where a natural head of water is not available, or it may be used in shaft sinking, although, for this purpose, a vertical one is preferable, as it can be slung in chains and takes up less room in the shaft. It is usual to supply a quantity of wrought-iron suction, delivery, steam, and exhaust pipe of proper size for this pump, with oval cast-iron flanges, jointed exactly in the same manner as used for hydraulic pipe joints, admitting of the pipes being jointed up with the greatest certainty and ease, or uncoupled with the same facility.

The cost of this plant, complete, with engines, boilers, crushers, amalgamating tables, mercury boxes, percussion tables, duplex pump, pipes, duplicates, stores and tools, including packing and delivery f.o.b., may be taken at about £4,200. (**Ape**).

Many forms of stamps have been invented and brought forward, amongst which may be mentioned Husbands & William's direct-acting steam stamps, Scholl's pneumatic stamp, elephant stamps, &c., but, for endurance, all these seem to give place to a well-constructed gravitation stamp, and when the continuous hard work (usually 24 hours per day) that these machines must be equal to is fully understood, we can then better arrive at the reason why these inventions, although very ingenious and perfect, give place to plain free-falling stamps.

Figure 3 is an illustration of a twelve-head battery of stamps, constructed with steel framing in a similar manner and style to those already described, but, on account of the difficulty of transport, the limit of weight for any single piece was fixed at 20 cwt., and this weight was reached by the cast-steel mortars. This only permitted of three head of stamps in one mortar; the falling weight of these stamps was 650 lbs. each. The plant was designed so that another twelve head of stamps could be added on the right

TEN-HEAD STAMP MILL. TIMBER FRAMING.

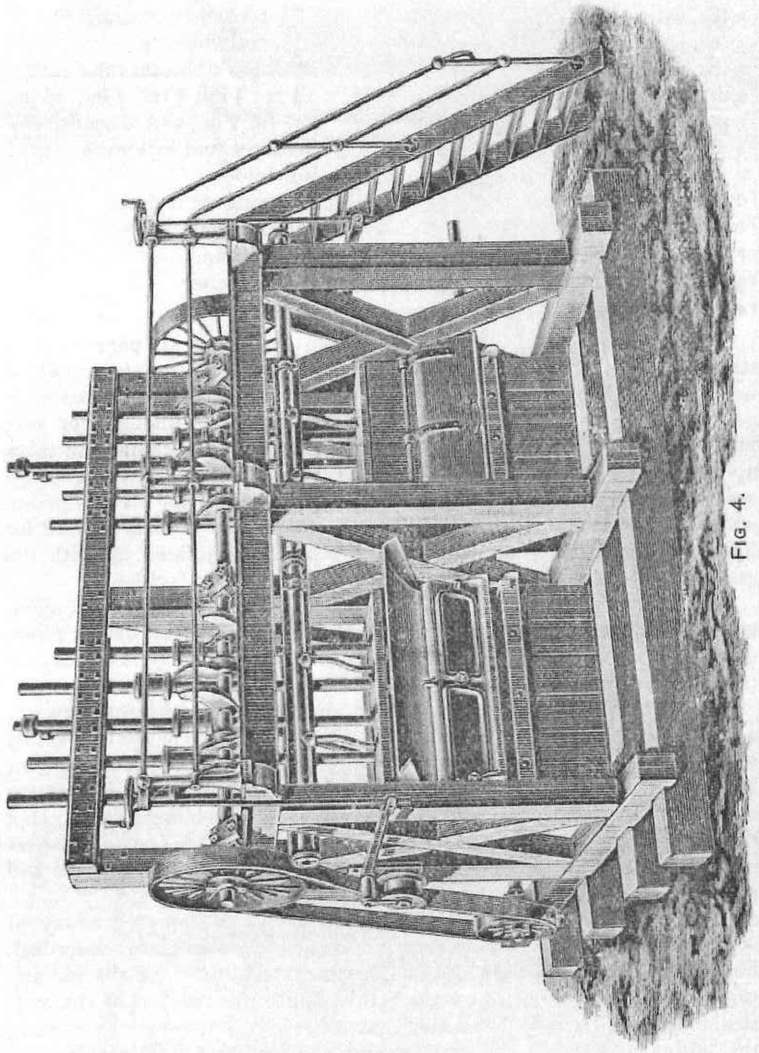


Fig. 4.

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hand side, and these have since been constructed and shipped. They were driven by a 20-H.P. nominal compound engine, with cylinders of 9 in. × 14 in. × 16 in. stroke and automatic expansion gear. It was made specially light on wrought-iron frame to come within the above limit of weight. A vertical sectional boiler of Cornes' patent, Figure 39, page 68, with large fire-box for wood burning was supplied, with water-tank and water-heater, duplex steam donkey pump, &c. This plant was commenced and shipped in two months from date of order, including complete erection and trial with ore in the works before shipping, and the second twelve-head was completed and shipped in six weeks from date of order.

We have described these plants very fully because we consider they embody every recent improvement, and contain all the essentials of a perfect stamp mill. These are, of necessity, expensive, but to meet the requirements of those who desire machinery less in first cost, we subjoin prices of stamp mills made in the same manner as that supplied by other firms, as also stamp mills with timber frames, and also prices for complete sets of ironwork, so that, in countries where timber and labour are cheap, purchasers can construct their own frames to drawings that will be supplied, giving every detail.

PRICES OF STAMPS of 650 lbs. falling weight.

CODE WORD	... ...	Ash	Bud	Cocoa	Drug
	NUMBER OF STAMPS	5	10	15	20
Ape	Stamps with wrought-iron or steel framing, steel mortars, &c. Figures 1, 2, and 3 ...	£330	£625	£725	£1,150
Bat	Do. do. with wood framing, cast-iron mortars, wood bearing, and strap-driven. Figure 4	£235	£450	£665	£850
Chick	Do. do. all ironwork, without the timber frames	£210	£410	£600	£750
	Nominal horse-power required	10	20	25	30
	Approx. shipping weight, tons	10	18½	28	37

PRICES OF STAMPS of 750 lbs. falling weight.

CODE WORD	... ...	Elms	Fir	Grape	Hazel
	NUMBER OF STAMPS	5	10	15	20
Dove	Stamps with wrought-iron or steel framing, steel mortars, &c. Figures 1, 2, and 3 ...	£350	£650	£975	£1,250
Ewes	Do. do. with wood framing, cast-iron mortars, wood bearing, and strap-driven. Figure 4	£250	£475	£700	£900
Fox	Do. do. all ironwork, but without framing	£225	£425	£625	£780
	Nominal horse-power required	10	20	30	35
	Approx. shipping weight, tons	10¼.	19	30	38

PRICES OF STAMPS of 850 lbs. falling weight.

CODE WORD	... ...	Ilex	Jay	Kernel	Lichen
	NUMBER OF STAMPS	5	10	15	20
Goats	Stamps with wrought-iron or steel raming, steel mortars, &c. Figures 1, 2, and 3 ...	£375	£800	£1,050	£1,400
Heron	Do. do. with wood framing, cast-iron mortars, wood bearings, and strap driven. Figure 4	£275	£500	£735	£950
Ibis	Do. do. ironwork only, without timber framing	£250	£440	£660	£825
	Nominal horse-power required	10	25	30	40
	Approx. shipping weight, tons	11	20	31	40

Packing for shipment extra.

It is sometimes imperative, from the difficulty experienced in overland transport, to make stamp mills and their accessories in sections, so that the heaviest pieces shall not exceed 300 lbs., and we have constructed several such plants most successfully, one of which was for the Wassau (Gold Coast) Mining Company; this was of generally similar construction to Figure 4, except that the falling weight of the stamps had to be reduced to 450 lbs. each, and the mortars had but two heads in each; these were of best crucible cast-steel, and were just over the 300 lbs. each, but to get sufficient weight to withstand properly the continued vibrations, they were bolted to wrought-iron slabs built up of two layers of iron, 1½ in. thick, in pieces the width of the mortars, and in lengths to come within the limit of weight. These slabs were planed true all over and were laminated so as to break joint, and were drilled with holes for countersunk rivets, which were put in at destination, so as to well reinforce the dead weight of the mortars and connect them together, three mortars or six head of stamps being thus connected together, making up a good solid piece to rest on the timber studding; this construction was found in practice to answer the purpose well. All other parts, such as the stone breaker, engine fly wheels, &c., had to be constructed in sections of the same weight. An extract from the Chairman's report to the shareholders on this machinery, from the *Mining Journal*, of April 26th, 1884, will not, we think, be out of place, seeing that it comes from an entirely independent source, and is in no way influenced by the makers :—

" The erection of the machinery was under the charge of Mr. Tate, " who went out from the works of Messrs. Cornes, Calvert & Co. for that " purpose. Mr. Tate has lately returned to this country, and his report, " personally, was most highly satisfactory. With regard to the machinery, " everything, he says, has been most perfectly done; from the massive " foundations that had to be put in, to the smallest rivet, everything fitted " to the sixteenth of an inch, as he expressed it, and I think Messrs.

" Cornes & Calvert (now Calvert, Cornes & Harris) should not be " without some recommendation for the very perfect way in which they " have fulfilled their contract in making this machinery. Some of the " timber foundations were very massive; there is one log, 35 ft. long × " 6 ft. × 5½ ft., of solid wood as hard as iron. The work has been " excellently well done in every respect. I am very glad to tell you that, " from letters received since this report was written, we hear that the " machinery is actually at work crushing."

This twenty-four head of stamps, for the reasons above given, was, of course, expensive, and every part was of the very best of its kind, and consisted of 20-H.P. engine, with two 10-in. diameter cylinders by 20-in. stroke, expansion gear, Roots' boilers, see page 66, Figure 117, crushers, steam pumps, suction and delivery pipes for same, water-tank, copper tables, mercury boxes, percussion tables, duplicates, laboratory, tools, &c., and the total cost of the whole plant was £3,200, packed in small packages (including all the fire-bricks, clay, chimney, &c., for boilers), and the total weight, 80 tons. (Ape)

The following parts may be taken as a general specification of ironwork, &c., comprised in our price list for ironwork, pages 17 and 18, for five head of stamps, the numbers being doubled for each additional five head :—

1 cast-iron mortar box with hopper and screen frame fitted.
2 steel or iron screens for do. do.
1 set of gland plates to secure mortar to studding.
1 sheet of indiarubber to seat mortar on top of studding.
5 stamp lifters.
5 ,, heads of cast iron with wrought-iron hoops.
5 ,, shoes.
5 ,, dies or anvils.
5 ,, tappets with keys.
5 cams for double lift of cast steel.
1 cam shaft of steel to which cams are fitted with sunk keys.
2 angle pedestals with gun-metal bearings complete.
1 wrought-iron pulley for cam shaft.
1 set of top and bottom guides for lifters with caps and bolts.
1 tightening pulley with carriage and screw complete.
5 stamp holders with sockets and pins complete.
1 cast-iron water pipe with branch to mortar, valve, &c.
1 complete set of bolts, strap plates, &c., for the wood framing to the design shown in Figure 4.
1 mounted, fully-dimensioned tracing, for constructing the wood frame, with a list of the various pieces of timber given for ordering from the mills.

The weights of these sets of ironwork may be taken approximately as follows :—

5 head 650-lb. stamps, 4 tons.
,, 750 ,, 6 ,,
,, 850 ,, 8 ,,

The cubic measurement of timber in each five-head battery will be approximately 200, 250, and 300 cubic feet respectively.

STEAM POWER PROSPECTING STAMPS.

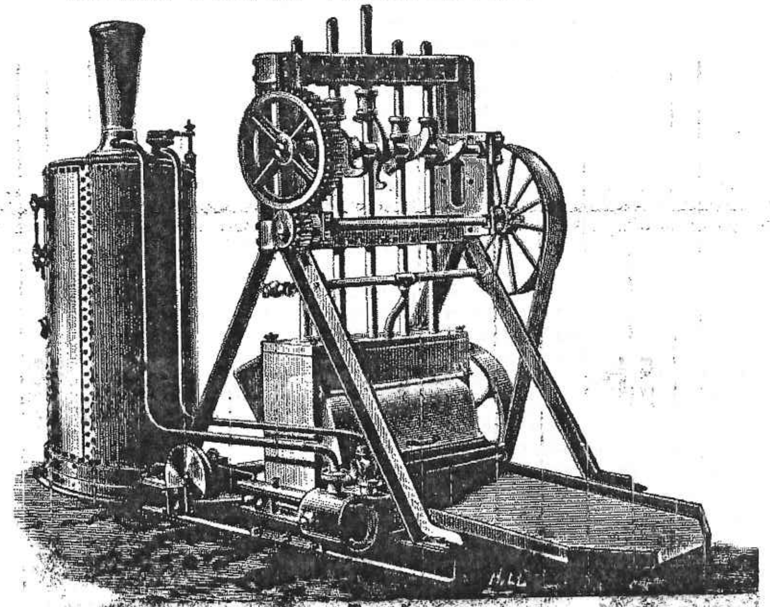

FIG. 5

HAND POWER PROSPECTING STAMPS.

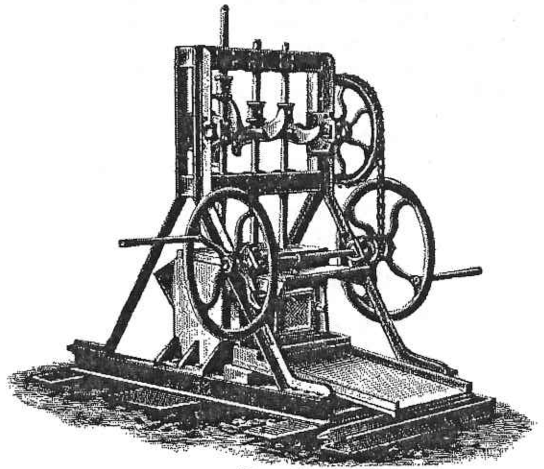

FIG. 6.

It will be obvious, that for trying ground or prospecting, a very light set of stamps will often be of great value, and not only to try new lodes, &c., but one that will give a continuous working result that may be kept going, and often paying expenses until other machinery of a permanent character can be got out and erected. For this purpose we construct a three to five head of stamps on wrought-iron frame, having a falling weight of 300 lbs., with a drop of 10 inches; this is driven by a small high pressure steam engine, bolted to the frame, as shown in Figure 5, and steam supplied to it by a light boiler of the fire engine type, the entire plant not exceeding 4 to 6 tons. It can be fitted with a set of wrought-iron wheels, axles, and bullock pole for transport if desired. The cost of such a plant is given below. If desired, the engine and boiler can be made independent, thus further reducing the weight for transport, but it cannot be quite so readily put to work. The cost will be the same in either case.

It will be noted that the total weight of these mills is not very great, while they have ample capacity for turning out a moderate quantity of work per day. The prices given below include copper table, counter-shaft, pulley, and straps complete.

CODE WORD	... ...	Ash	Bud	Cocoa
Ape	NUMBER OF HEADS	3	4	5
	Stamp prospecting mill, Figure 5	£200	£250	£300
	Approximate weight ... ... tons	4	5	6

We also make a still smaller set of prospecting stamps with three heads, each having a falling weight of 150 lbs., that are so portable that they can be transported and worked by hand power. These stamps are shown in Figure 6, and are mounted on a neat angle iron frame. All the parts are bolted together, so that it can be readily erected together on its arrival on the site, or as readily disconnected and removed to another site. It can be worked by four men, the handles being made long enough to permit of this. The same construction is observed on these prospecting mills as the larger ones, the difference being only one of proportion.

CODE WORD	... ...	Drug
	NUMBER OF HEADS	[illegible]
Bat Chick	Hand-power prospecting stamp mill. Figure 6	£60
	Horse or bullock gear for same	£20
	Weight of stamp mill ... ... tons	1½
	Weight of bullock or horse gear ... ... ,,	1

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Packing for shipment, 3 per cent. extra.

57651

HUNTINGTON'S CENTRIFUGAL QUARTZ MILL.

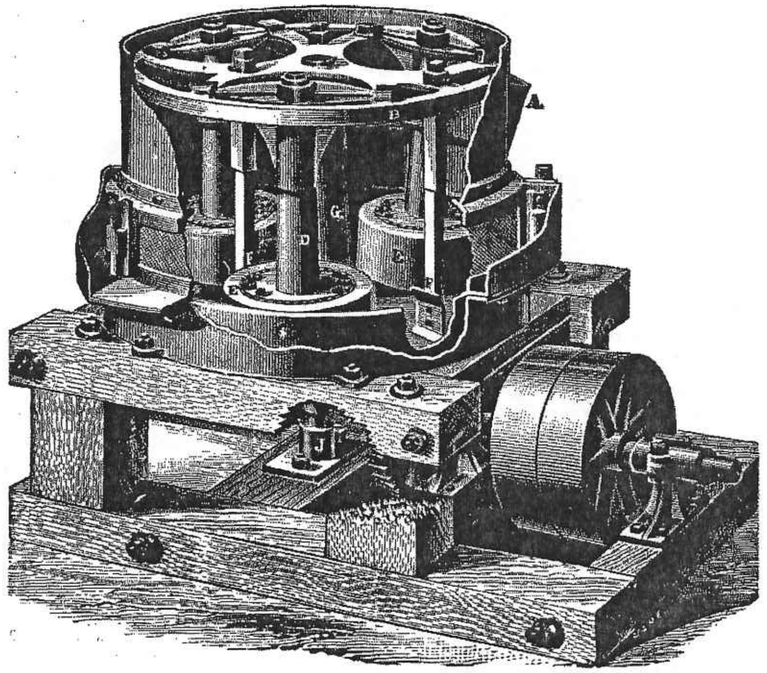

Fig. 14.

The action of the Huntington mill may be briefly explained as follows: The ore and water being fed into the hopper, A, the rotation of the rollers, E and F, cast the same against the outer steel ring, where, by means of the centrifugal force of the rollers travelling over it, the ores are crushed to a sufficient fineness to pass the screens against which the ground materials are also thrown by the centrifugal action, giving a most perfect discharge, making little or no slimes, thus leaving the amalgam in the best condition for concentration.

The rollers are suspended from the top driving-frame so as to leave them one inch from the bottom of the pan, and thus passing clear of the amalgam without grinding it or throwing it from the mill, but, at the same time, giving sufficient motion to it to make the amalgamation perfect. For wet crushing or milling and gold-saving this mill gives excellent results.

This mill has now stood the test of several years' working, and in this class of mill far exceeds all competitors, and it is now extensively used in all mining districts throughout the world; the inventor claims the following special points in favour of its use in preference to stamps:—

SECTION OF GOLD MILL (HUNTINGTON SYSTEM).

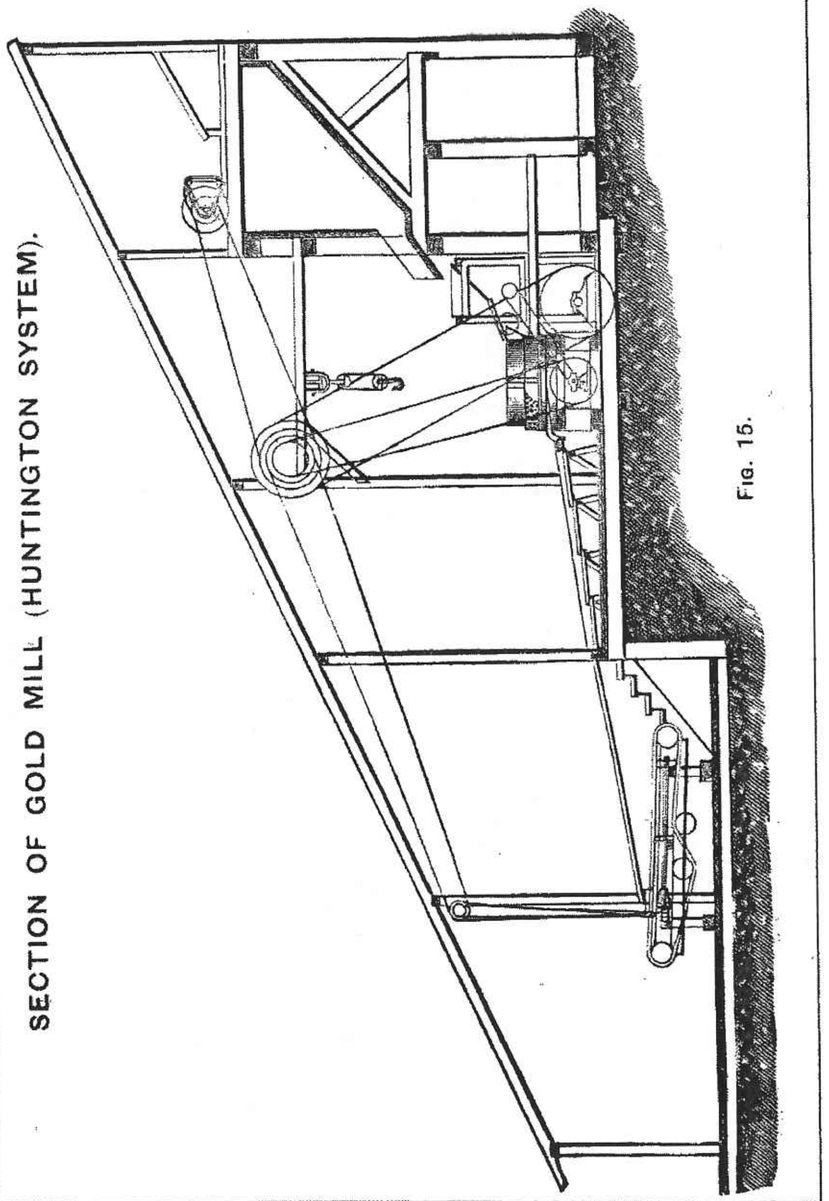

Fig. 15.

1. The cost of same capacity one-half that of stamps.
2. Freight or carriage one-fourth less than stamps.
3. Cost of erection one-tenth that of stamps.
4. Less power per ton of ore crushed.
5. Less wear and tear than stamps.
6. More easily duplicated than stamps.
7. Discharges better and leaves a better amalgam.
8. Better amalgamator and gold-saver.
9. Greater simplicity of construction.
10. It is continually crushing and works comparatively silent, and prevents *all flouring* of the gold and quicksilver and consequent loss.

It is particularly recommended for working ores containing sulphurets, the rotary motion of the rollers leaving the ore so granulated—and which it discharges the moment it is fine enough to pass the screen—that a complete concentration of the sulphurets is afterward rendered perfectly easy.

The numerous testimonials received by Mr. Huntington all bear witness to the great value of this invention.

It is made in two sizes, as given in the list below. A smaller size can be made for places where transport is most difficult, but is not recommended.

CODE WORD	... ...	Ash	Bud
	Diameter ... ... feet	5	6
	Capacity per day ... ... tons	20	30
	Revolutions per minute	70	55
	Nominal horse-power	6	8
Ape	Price	£312 10	£469
	Approximate weight ... ... tons	5	9

Figure 15 shows the end elevation of a mill in which the above mills are used instead of stamps, and with copper tables and Frue Vanners for the fine concentration.

An ore crusher is used at the top, as in the ordinary stamp mill, the ore falling upon a grizzley or into a rotary screen to take out the fine stuff, and the other is then passed through the crusher, and both falling into the storage hopper or bin. A shoot from this bin supplies one or more automatic ore feeders. Figure 52, placed at a sufficient elevation to discharge regularly its contents into the Huntington mill; the pulp discharged through the screens flowing over a series of electro-plated copper plates and the tailings on to the Frue Vanners.

This same arrangement of mill will work silver ores, omitting the electro-plated amalgamating plates.

It will be obvious that any number of these "Huntington" mills may be fixed in line, each mill having its ore feeder and two Frue Vanners. One ore breaker will serve two mills.

The cost of crushing by these mills is stated by some authorities as not exceeding 1½d. per ton, including power, renewals, oil, depreciation, &c., arrived at from an average of some 36,000 tons of stuff, the ore being 27 cubic feet per ton of hard quartz and tough slate.

Packing for shipment, 3 per cent. extra.

MARSTON'S PATENT ROCK DRILL.

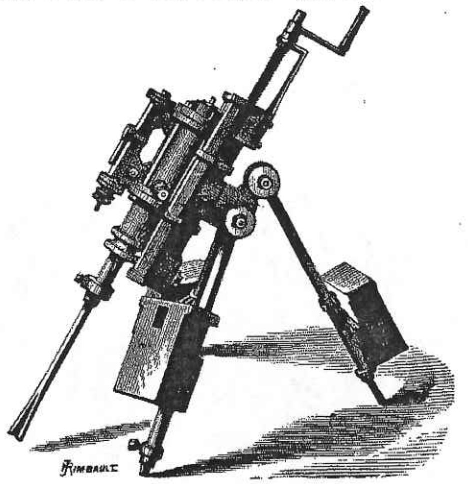

Fig. 16.

The use of a really good rock drill to miners needs no comment, and the drill above illustrated can be thoroughly recommended, it having been worked out in all its details by practical miners with practical engineers. They are in constant daily use with steam or air in some of the hardest granites in this country.

The drill strikes a dead blow, steam or air not being admitted until after the blow. We recommend them with hand feed instead of automatic, no object being gained by the latter except increased cost and complication. These drills can be fitted to stretcher bar for heading or tunnel work (see prices below), or with "gadding" cars to carry any number of drills, prices of which will be given on receipt of data as to number of drills and size of heading.

CODE WORD	... ...	Ash	Bud	Cocoa	Drug	Elms
	Diameter of drill cylinder ... inches	2½	3	3½	4	5
Ape	Price of drill, Figure 16	£40	£47	£53	£60	£75
Bat	" tripod stand and weights ...	£6	£6	£7	£7	£10
Chick	" stretcher bar and clamp ...	£9	£9	£10	£10	£15
Dove	" one set of drills	£7	£7	£8	£8	£10
Ewes	" " drill swages ...	£1	£1	£1 10	£1 10	£2
Fox	" indiarubber hose, per foot ...	3/-	3/-	3/-	3/-	4/-
Goats	" gun-metal unions, per set ...	14/-	14/-	15/-	15/-	20/-

Duplicates of any of these drills can be supplied, and, for foreign orders, a small stock should always be taken. Wrought-iron air pipes, with hydraulic flanges, are recommended.

IMPROVED AIR COMPRESSOR.

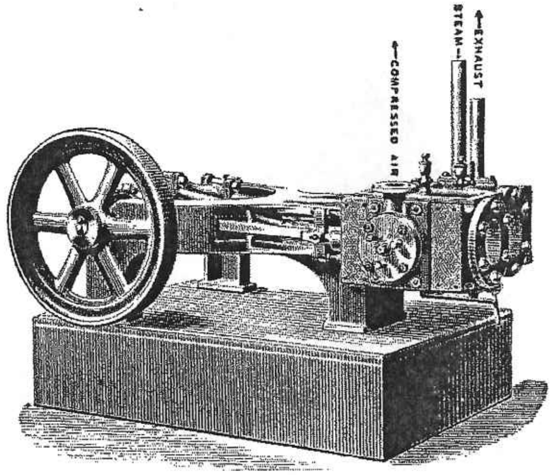

Fig. 17.

The above engraving represents a neat and handy design for an air compressor, suitable for working one to three rock drills of the type shown in Figure 16, according to size of drill. It will be noted that the steam and air cylinders are side by side and the cranks at right angles to each other, so that the engine is exerting its greatest effort when the air is at its greatest density and on the point of delivery into the air receiver. The compressor cylinder is water-jacketted, and water jet pipes are also sometimes used to cool the cylinder and fill up the clearance spaces, this water separating itself from the air in the receiver. These machines are made in three sizes, and they can be supplied fitted on the top of air receivers standing on cradles which serve as a foundation, or they can be supplied with two air cylinders, to be driven by strap from any form of motor, at the same prices as given below.

CODE WORD	… … … … … … … … … … …	Ash	Bud	Cocoa
Ape Bat	Diameter—steam and air cylinders, inches	7½ × 6¼	10 × 8½	12 × 10
	Price—Figure 17 … … … … … … …	£65	£77	£95
	Price of suitable air receiver with safety valve, stop valve, &c. … … … …	£50	£60	£70

These compressors give a very good diagram, the compressor cylinder being fitted with slide valve driven from the engine shaft, giving an absolute motion to the valve. Larger sizes, either with simple or compound engines, of the side-by-side or tandem type, will be quoted for on application, and designs furnished. Where water power is available they may with advantage be driven by turbine or water-wheel, or a column of water used to compress directly.

ORE BREAKERS.

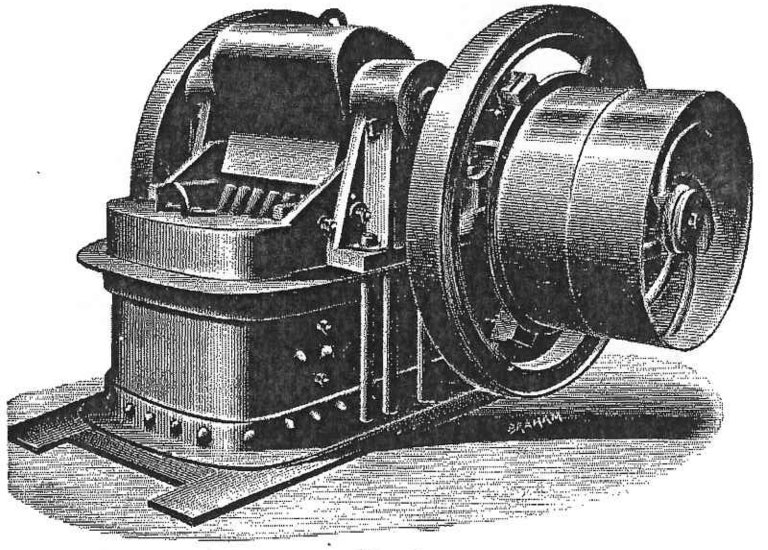

Fig. 7.

The construction of these useful machines, invented by Colonel Blake, is now so well known, that it needs but little description: the improvements that have taken place being more in detail than principle. For facility of transport we construct them in sections, and with cast-steel frames, &c.

CODE WORD	… … … … … … … …	Ash	Bud	Cocoa	Drug	Elms
Ape Bat	Size of jaws, … … … inches	12 × 8	15 × 10	18 × 10	20 × 10	24 × 13
	Approx. quantity per hour, tons	4	5	6	8	10
	Horse-power required… … …	4	5	7	8	10
	Price … … … … … … …	£95	£125	£138	£150	£220
	Price for sectional machine …	£125	£200	£250	£300	£400
	Approximate weight … tons	4	5	6	7	8
	Speed—revolutions per minute	300	275	275	250	250

Larger machines are constructed, but it is usually the better practice to take two or more machines instead of larger sizes than given in the above list.

ORE BREAKER WITH WOOD FRAME.

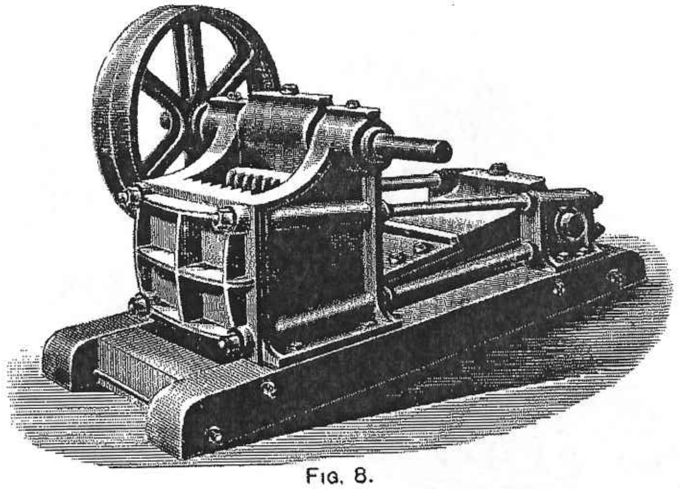

FIG. 8.

A handy form of sectional ore breaker is shown in our engraving, Figure 8, and not an expensive one, for districts where good timber is abundant and good labour obtainable. It will be noted that the under frame is entirely of wood, the "Pitman," or connecting rod, becomes the jaw itself, the eccentric shaft working direct on it, and a single toggle plate is fitted to the lower end of the movable jaw, the movable jaw having thus a compound motion, which action is found for granulating or crushing to be superior to the ordinary "Blake" action, while the number of working and wearing parts are reduced to only five, making also the simplest machine and lightest for transport.

The strain due to the crushing action of the toggle plate and eccentric shaft is taken by four steel bolts. The rest of the castings are also of steel, and the prices include, in each case, the whole of the bolts and plates for building up the framing, together with a proper dimensioned tracing of same for the use of the builder or carpenter.

CODE WORD	... ...	Ash	Bud	Cocoa	Drug
Ape	Size of jaws ... ... inches	10 × 4	10 × 7	12 × 9	18 × 10
	Price	£55	£100	£135	£190
	Approximate weight ... tons	1½	3	4½	6

Speed and quantities of ore crushed may be taken the same as given for Figure 7, and it will be observed the prices are about midway between the ordinary breaker and the special sectional type, with steel framing.

We construct a small machine worked by hand, which weighs about 1½ cwt., suited for experimental purposes. Price about £15.

Any of the breakers can be fitted with rotary screens, at an extra cost of from £10 to £20, and the cost of the driving belts at from £7 to £11.

PATENT CRUSHING ROLLS.

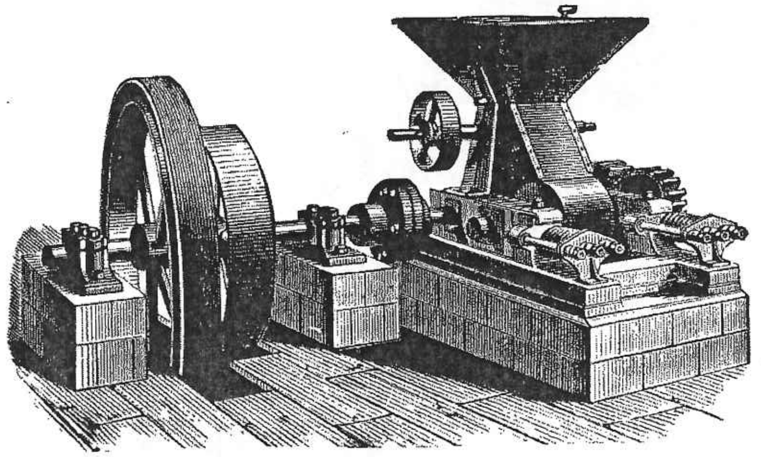

FIG. 9.

The rolls shown (Figure 9) are for the purpose of crushing all kinds of minerals, and they are entirely self-contained, the pressure being given to the rollers by means of india-rubber buffer springs, instead of the old and cumbersome plan of weighted levers (usual in the old Cornish rolls). The rolls are made with loose steel shells from the best crucible cast steel, and are arranged so that they can be readily renewed when the roller surfaces are worn too thin.

The whole of the working parts, such as the bearings, are most carefully protected from the grit, and ample means are devised for lubrication. The rollers are fitted with feed hopper and feeding roll, ensuring steady and regular feed, being driven by a strap, which has been omitted in the engraving. It is also fitted with a heavy fly-wheel, which greatly helps the strap, carrying the rollers over any extra feed or unusual hard lump, that would otherwise throw off the strap. Sometimes they are fitted with spur gearing, but for moderate sizes we prefer to drive direct, as shown with a fly-wheel.

CODE WORD	... ...	Ash	Bud	Cocoa
Ape.	Diameter of rolls ... ... inches	20	24	30
	Length of rolls ... ... „	12	15	18
	Number of revolutions per minute ...	16	14	12
	Approximate quantity of ore crushed per hour ... ... tons	3	5	6
	Price	£70	£120	£145
	Approximate weight ... ... tons	4	5	6

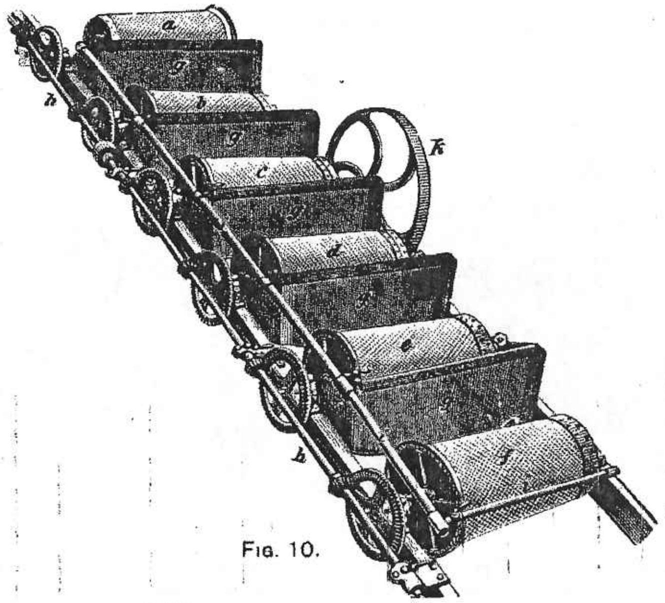

Fig. 10.

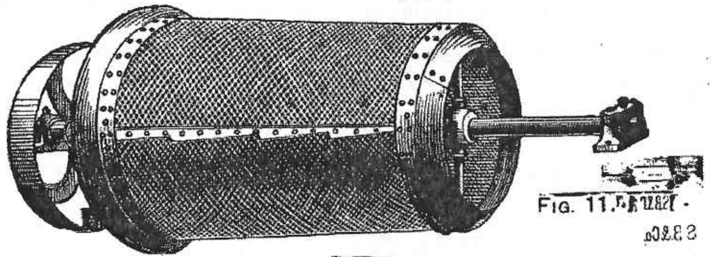

Fig. 11.

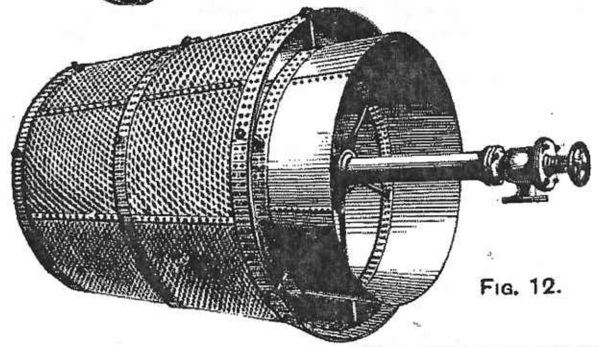

Fig. 12.

SIZING SCREENS OR CLASSIFIERS.

The sizing screen classifier, or trommel as it is sometimes called, in all processes of coarse concentration plays a very important part, and usually precedes the operations of the syphon or plunger jigger, Figure 21, or the percussion table, Figure 18, and the successful working of any machine of this class, where the separation is dependent on the gravity of the particles of ore operated upon, will be greatly affected by proper sizing.

One of these arrangements is shown in Figure 10, and consists of six screens driven from a line of shafting at right angles to the axis of the screens by bevel gearing. The ore is fed into *a*, and the finest separation passes through this screen, the remainder going through the end and into the iron shoot, *g*, which conducts it then into *b*, where the next finest sample is separated, the remainder to be again taken into *c*, and so on through the whole series of the six screens.

Sometimes the classifiers are fixed end to end, the stuff falling from one to the other, the top screen driving the one below by means of a pair of spur wheels, and in some cases the same result will be arrived at by using a single screen of larger size, made in sections of larger diameters from the feeding end, each section being covered with punched iron or steel plates of the required gauge, but where a large quantity is required to be operated upon, the arrangement of screens, Figure 10, or the screens end to end, are the best and most used.

Where a very fine separation is desired the wire cloth is substituted for the perforated plates.

Figure 11 is engraved from a conical revolving screen of the usual type, while Figure 12 is a double or compound screen which is useful in some cases where space is of importance. The wire cloth or perforated metal plates are fixed to the cylinders by the wrought-iron straps shown in the engraving; in Figure 11 they run parallel with the axis, and in Figure 12 the strap plates are circumferential.

The forms of revolving screens are legion, and we have merely given hose illustrated and described as types, in addition to which there are parallel simple screens, parallel compound screens, parallel stepped screens, screens with raft or lifting wheels at their ends, screens with solid axes and hollow spindles with water service by means of gland pipes fitted to the ends, each description having its separate use and advantage and partisans. Within the scope of this small book it will be impossible to fully enumerate or illustrate the whole series, but, on application, with data as to purpose for which the screens are destined, together with the quantity to be operated upon within a given time, full designs and tenders will be furnished.

The full list of prices for perforated iron and steel plates and wire cloth or gauze will be found at pages 83 and 84, with illustrations of same. For conical screens the sheet can be perforated to size, leaving a margin all round the edges, which strengthens the plates very much and facilitates the attachment. Where possible, this practice is advisable in all screens rather than cutting from stock sheets into the perforations.

PLUNGER JIGGERS.

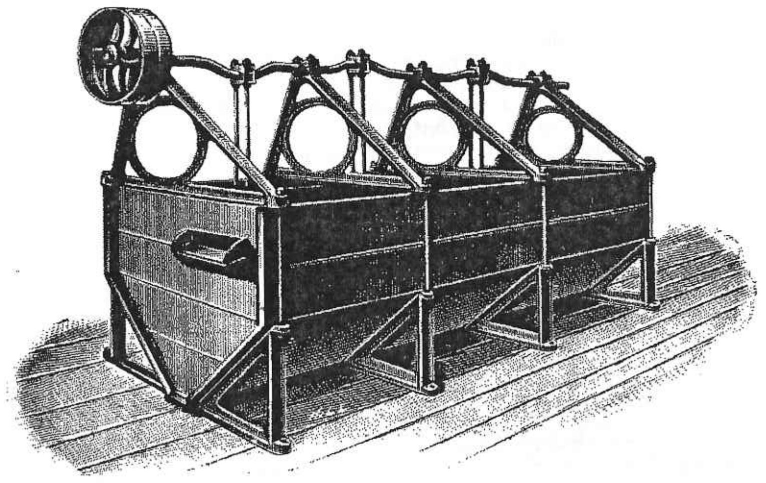

Fig. 21.

The above figure represents one of the most usual forms of this excellent concentrator, and which may be taken as a mechanical refinement, or application of the well-known hand jigger, the only difference being that while the old hand jigger consisted of a sieve or screen, in which the ore was contained, being hung on to a hand lever, and to which a vertical reciprocating motion into water contained in a tank below was given, the mechanical jigger consists of a plunger having a vertical reciprocating motion, which causes the water to rise up below a fixed screen containing the ore, with a regular pulsation.

These mechanical jiggers are, as before-mentioned, of the form given above, which consists of a long wooden box with a pointed bottom partly divided longitudinally, but leaving the bottom open and forming a sort of syphon, the box being divided transversely in three or more separate divisions on one side, each compartment fitted with screens, and the opposite side with plungers.

The plungers are of wood, loosely fitting the compartment or one leg of the syphon, and a short, quick vertical motion is imparted to the wood plunger or piston, causing the water to rise in the opposite leg of the syphon under the screen on which the ore is fed, and it is a well-known principle that particles of ore—properly classified by means of the revolving screens or trommels, Figures 10 to 12—of one size, having a different specific gravity, will, when this action is imparted to them by

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water or percussion, arrange themselves into layers according to their gravity—the heavier particles, of course, going to the bottom, to be finally discharged through the screens or by suitable discharge openings, while the lighter portions move horizontally over the end of the screens.

Sometimes these jiggers are made with four compartments, this being the case when more than two products are desired.

In the design of the jigger shown the strokes of the pistons are fixed, and where the treatment of ore is past an experimental stage, this, on account of its simplicity, is preferred. The speed can be varied by means of a countershaft with cone pulley. They can, when desired, be fitted with adjustable eccentrics at the same price, and such an arrangement is recommended, if the ores to be treated have not been worked before, as the success of this process much depends on the proper sizing or classification, together with a suitable stroke and speed of the water piston, to the ore and screen—by some authorities, an irregular or tappet motion to the water plunger is preferred—and jiggers so constructed will be supplied when desired, but as most of the machinery in general use is with a constant motion, the balance is in favour of using it and avoiding the more noisy and complicated machine.

Our illustration shows a jigger of what we may term composite design, that is to say, while the body of the box is of wood, the under frames carrying it are of iron, as also the frames carrying the crank shaft, the two sets of frames bolting the box firmly together, and this construction is good and moderate in first cost; but where good timber and labour is cheap, it is then usual to construct the whole of the under and upper frames of wood as well as the box, and we quote for sets of ironwork only for such construction.

It is sometimes also usual on account of climate or difficulty in obtaining timber or labour, to make the syphon box of wrought iron, and the list below gives prices for these.

CODE WORD	... ...	Ash	Bud	Cocoa
	Number of compartments	2	3	4
Ape	Price of machine complete, as Figure 21 ...	£35	£40	£45
Bat	" " ironwork only, as Figure 21	£22	£28	£35
Chick	" " " " for timber frames...	£15	£20	£25
Dove	" " machine with wrought-iron box, complete	£45	£50	£55
	Approximate weight, Fig. 21, complete, tons	¾	1	1¼

Jiggers have, in some instances, been made with cast-iron syphon boxes, but the castings were both risky and costly, in addition to being much heavier than wood or wrought iron, and the practice cannot be recommended.

A rather neat design for obtaining a nearly vertical stroke to the plunger or piston, and at the same time making it variable, is much used in Germany, and consists of a variable radius crank pin coupled by a connecting rod to a horizontal lever, which is keyed to the end of a plain bar taking the place of the crank, on which are short wipers over the centre of each plunger, this bar having only an oscillating motion.

AMALGAMATING PANS AND SETTLERS.

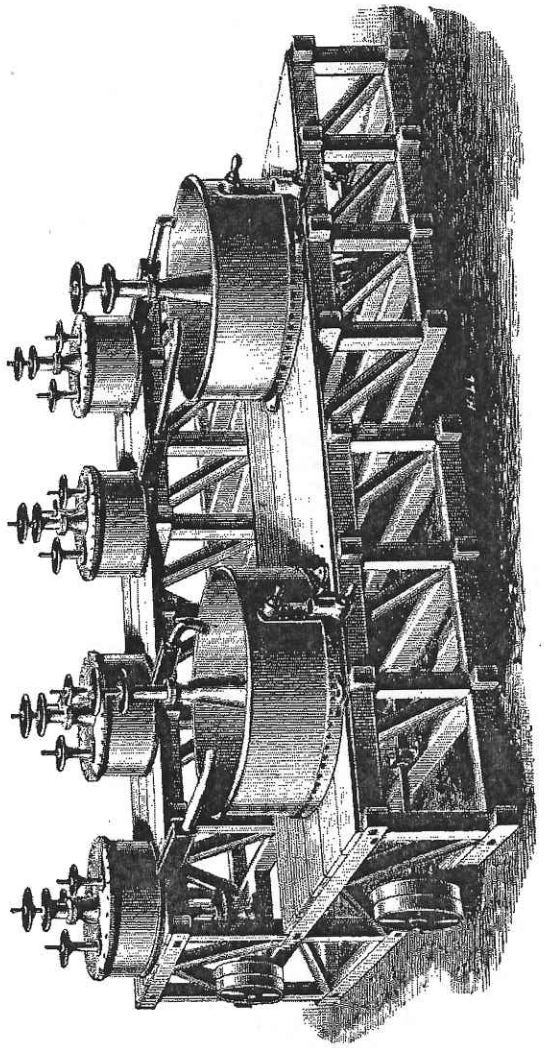

FIG. 22.

The amalgamating pans and settlers, shown in our page engraving, Figure 22, show the most improved design of these machines, with a good general idea of their arrangement. The usual plan is to have two amalgamators to one settler. The amalgamators are shown at the highest level, and consist of cast-iron pans, of 4 ft. and 5 ft. diameter, 5 ft. however, is the usual and best size, and this size requires an 8 ft. diameter settler to each pair of pans. The bottom of the pan is jacketted, as also the central cone, into which live or exhaust steam is admitted, and much assists in the operation, provided the temperature be not too high. The inside of the bottom of the pan is fitted with hard cast iron that can be readily renewed, and the mullers have also loose adjustable shoes—these mullers being readily adjusted by means of the hand-wheel and screws on the top of the pan, to bring the surfaces into contact when grinding, or raised from the dies on the bottom of the pan when required for agitating or mixing.

The pans are driven from below by mitre gearing and a short separate horizontal shaft to each pan, fitted with fast and loose pulleys, enabling any pan to be stopped or started independent of the other. These pans and settlers for cheapness are made with cast-iron bottoms and wood staves, hooped like a barrel, but, unless for the convenience of transport, such a construction cannot be at all recommended.

The settler is also constructed entirely of iron, the bottom being in cast iron, and the cylinder of wrought iron with a half-round iron ring to stiffen the top edge. It is 8 ft. diameter × 3 ft. high, and is fitted with circular muller with wood shoes adjustable by means of screw and hand-wheel. The cast-iron bottom is grooved around its circumference, the groove being deepest in the front, at which point it is fitted with syphon tap.

The settler is driven from below in the same manner as the pans, by means of bevel gear and fast and loose pulleys, the upright shaft is carried by the cone and in a foot step, having hardened steel bearing washer, the foot step is carried by one of the cross timber sills of the framing.

CODE WORD	... ...	Ash	Bud
Ape Bat	Diameter of pans ... ... feet	4	5
	" settlers ... ... "	6	8
	Price per set of 2 pans and 1 settler	£200	£300
	Ditto, made with wood staves	£155	£260
	Revolutions of pans per minute	80	65
	" settlers "	16	12
	Weight per set in iron ... ... tons	6	9
	Horse-power actual per set	10	14

The above sets will get through about 1½ ton per hour for the 4 ft. set, and the 5 ft. set about 2½ tons per hour.

These pans and settlers can be made sectional at 10 per cent. above the prices quoted above.

Agitators and **Clean-up Pans** are very similar to the foregoing, the agitator really being an additional settler, and the clean-up pan an amalgamator to treat dirty and impure stuff, which can, if desired, be repassed through one of the amalgamators.

"BERDAN" PAN AMALGAMATOR.

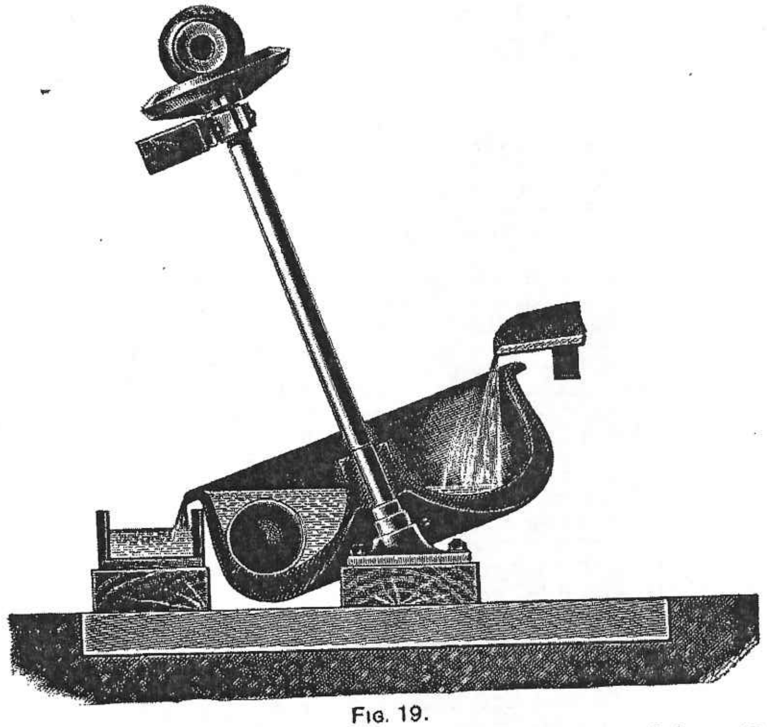

Fig. 19.

The "Berdan" pan, Figure 19, so named after its inventor, is by many mill men preferred to the other types of amalgamators, and for cheapness, simplicity, and non-liability to wear and derangements, it has much in its favour. A sectional view so clearly shows its construction as to render any description almost unnecessary. It consists of a circular cast-iron pan, about 4 ft. diameter, made of the shape shown (the bottom of the pan being made very thick where the wear takes place), this is hung upon an axis fixed out of the vertical, and is driven by bevel gearing at the top end, usually a number of pans being driven from one shaft. In this pan a cast-iron ball, of a diameter to nearly fit it, is free to revolve as the pan is rotated, giving a capital grinding and amalgamating action. The slimes are admitted to the pan by the launder at the top edge and overflow at the lower lip into a launder, to be further treated if found of sufficient value. The cost of these pans, including vertical shaft, toe step bearing, top bearing, driving wheel, and pinion, but exclusive of the horizontal driving shaft is (Ape) £60 per set, and the weight per set is 40 cwt. One of these pans is required to each five head of stamps.

HALLEY'S PERCUSSION TABLE.

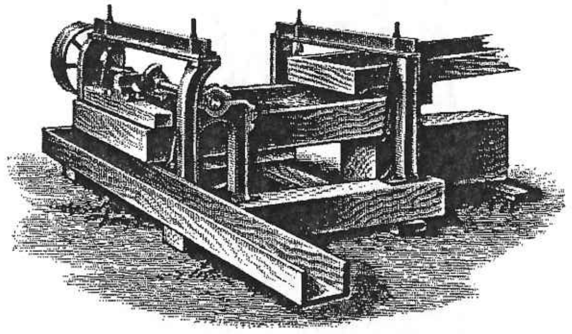

Fig. 18.

The percussion or shaking table shown in our illustration, Figure 18, is a simple concentrator, and much used in the Australian Colonies, where amongst mill men it has found much favour, and, since its introduction there, its use has now extended to all parts of the globe. The machine and its action may be briefly described as follows: A tray or table, of about 8 ft. long × 4 ft. wide, is hung in slings from its four corners on an incline, this incline capable of being adjusted and regulated by the screws at the top of each sling, and by the rotation of a three-tooth cam working against a spring, a reciprocating motion is given to this table, and as each tooth of the cam passes the toggle, the spring brings it back against a suitable buffer affixed to a bed log, with a smart shock or percussion. The pulverized ore with water is fed on to this table at its upper end, from the launder shown, the shocks from the spring against its buffer-beam tending, together with the stream of water, to carry over the light or earthy portions of the mineral, while the heavy or metallic portions are retained in the depressions of the table, and from which they are cleaned up from time to time.

One of these tables is required to each five head of stamps, or say, two to each Huntington mill. They are generally arranged in pairs, the driving pulleys being brought together, right and left hand, for the convenience of driving and working.

CODE WORD	... ...	Ash
Ape	Price of machine on wood frame	£75
Bat	" " iron "	£85
	Average speed of driving pulleys, revolutions per minute ...	60
	Approximate weight ... ... tons	1½

These tables have been found to give, with some ores, most excellent results, but a first classifying is sometimes found desirable.

CORNES' PATENT VANNER OR CONCENTRATOR.

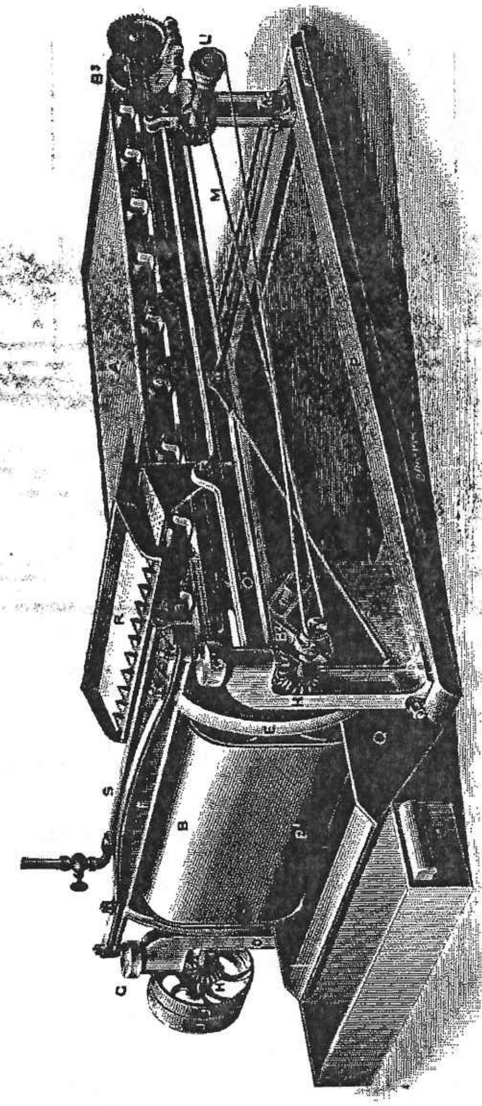

FIG. 23.

CORNES' PATENT VANNER OR CONCENTRATOR.

The term "vanning" is derived from a Cornish word, and is used to represent the operation of washing ores on a shovel or in a pan with a side or partial circular motion, whereby the light or earthy portions are carried over the edge with the water, leaving the heavier metallic portions in the hollow of the vessel. This operation will be familiar to everyone connected with mining operations. On the Gold Coast, this operation is generally performed by native women with a very shallow wooden tray, standing frequently in water, into which the vessel is from time to time partially dipped, and this is the process used by most of the diggers when at work in alluvial soil, until better appliances have followed, as the properties become developed. This is by them called "panning," and we are inclined to believe that "vanning" is a Cornish or German corruption of the word.

The mechanical contrivances to conduct this operation on a large and continuous manner have been both numerous and ingenious. The machines that have achieved the greatest measure of success, are, for coarse concentrates, the percussion table, Figure 18, page 37, and for very fine concentrates, the vanner, which was, we believe, originally used in Germany, and consisted of an endless travelling belt on a slight incline, on to which the slimes with water were fed, this belt having a slight tremulous motion or end blow imparted to it, the light or worthless portions being washed away down the incline, while the heavier parts adhere to the belt travelling over the incline, and the belt on its underside passing through water they are detached and are collected in the water box.

This machine, like all such contrivances, has, from time to time, received many improvements, most notably the introduction of a loose framing carrying the belt, and to this frame a quick longitudinal vibrating motion was given, and called "Embrey's" concentrator. This gave place to one with a side shake instead of end shake, and is known as the "Frue" concentrator.

We claim for our concentrator that it possesses the combined advantages of all these previous efforts, having a quick circular side and end motion at the head of the incline, resolving itself into nearly an end shaking motion at the foot of the incline, and to this combined motion a slight end blow can be used if desired. This compound motion will be found to represent the action of "vanning" or "panning" nearer than any other machine yet introduced, and will, therefore, give a more perfect result. It may seem strange that, while previous inventors have all used portions of the motion best calculated to produce the effect of hand work, none have before done so, as the machine is as simple to make with the compound perfect action as with the less perfect action.

The machine may be briefly described as follows:—A travelling india-rubber band, about 4 ft. wide × 12 ft. long, A, passing round four rollers, B, B^1, B^2, B^3, three of which are fitted with an adjustment for the purpose of tightening the belt or causing it to run truly on its rollers, B^3 being the driver by means of the worm and tangent wheel, C. The belt is also supported on nine small diameter rollers, D^1 to D^9, carried on an angle iron frame, E. This frame is made of suitable form to carry all the four main belt rollers, D, and their adjustments, and is in turn carried by a cross girder, F, at its upper end, having two hardened studs at its ends. These studs are stepped into a pair of crank discs, G, G^1, keyed on the ends of two short vertical shafts, which are both driven by two sets of mitre wheels, H, H^1, and the horizontal pulley shaft I, and pulley, J, J. The lower end of the belt frame, E, is carried by two friction rollers K, working at a slight incline in the angle of the angle iron frame, and thus admitting of either end or slight side motion at this point, which will, of necessity, be due to rotative action of the discs, G, G^1, transmitting motion to the cross girder, F, and frame, E.

The speed of the travelling belt can be varied by means of the two coned pulleys, L, L^1, and belt, M, the spindle carrying the worm having a sliding motion in the sleeve of its mitre wheel, and is also fitted with universal joint, N, so as to be quite independent of any action due to the shaking table. The whole apparatus is mounted in a pair of side frames O, O^1, and on a timber under-frame, P. Q is the ore depositing box. R, the distributing box, which can be adjusted to any angle, and is arranged to divide the concentrates evenly over the surface of the belt, this action being much assisted by its compound action. S is the water-distributing pipe furnished with a number of small jet pipes.

The method of working is as follows:—The ore is fed on to the belt by means of the feed spreader in an even stream, so as to deposit about ⅜ of an inch on the belt. The necessary amount of water from the water-distributor should be turned on, the machine set in motion, the pulleys making from 180 to 200 revolutions per minute, and the proper rate of travel given to the belt by means of the cone pulleys. This will vary considerably with the ore under treatment, as also the incline of the machine, which can, by means of wedges under the sills, be adjusted. This will vary from 3 in. to 6 in. in the length of the machine, but when once these details have been found, the machine will work with little or no attention, except oiling and keeping clean, and, from time to time, scraping the concentrates from the bottom of the box into the loose box, which may be made on wheels if desired. Very little power is required to work these machines, one horse-power nominal being sufficient to drive two machines, and they will turn out 5 to 6 cwt. per hour. Two machines are required to each five head of heavy stamps, but one machine will do for say five head of 650 lbs. stamps.

The cost of working these machines is very low indeed, 1/- to 1/6 per ton may be taken as an average. The price of the machine complete, on iron frame, is £110 (Ape), and weighs, when packed, about 1 ton.

CORNES' CONTINUOUS ORE FEEDER.

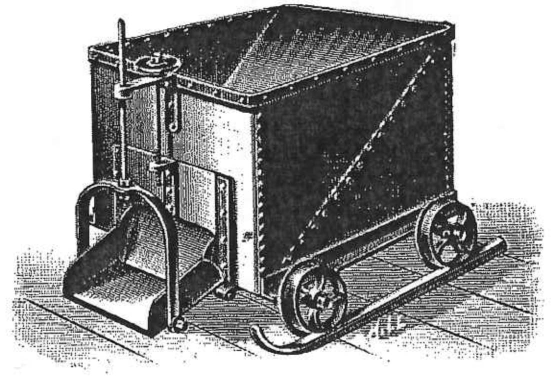

FIG 52.

In many mills it is not always convenient or desirable to feed the batteries or Huntington mills direct from the storage hopper, and where this is the case, an ore feeder running on tram lines and wheels, as shown in our Figure 52, or the wheels and rails can be placed at right angles to those shown, and this arrangement, where a number of mills are in line, will often be found the best. These feeders are constructed entirely of iron, much better adapted to all climates and the work they have to perform than the flimsy wooden-framed machines generally used. The feeding shoot can be coupled up to the tappet on the centre stamp stem, and will at each blow feed a given portion of ore into the mortar, which amount can be regulated to the greatest nicety. The regular feeding of ore to any kind of stamps or crushers is a matter of the greatest importance, as much more work can be got through in a given time, better work produced, and therefore will save more gold. Regular mechanical feed reduces hand labour, wear and tear of stamp shoes, dies, and grate screens.

When these feed hoppers are arranged to feed Huntington mills, the arrangement to the feeding shoot is then slightly altered, so as to be driven or operated by rotary motion from a small pulley on the pulley shaft of the mill, or from a pulley on the countershaft.

Each hopper holds about 2 cwt. of ore, and occupies a space of 4 ft. from back to front, 4 ft. high × 3 ft. wide. Total weight, about 5 cwt. Price—£15 each for tappet feeding (Ape), £16 10s. each for rotary feeding (Bat).

NEWBERY-VAUTIN (PATENT) CHLORINATION PLANT.

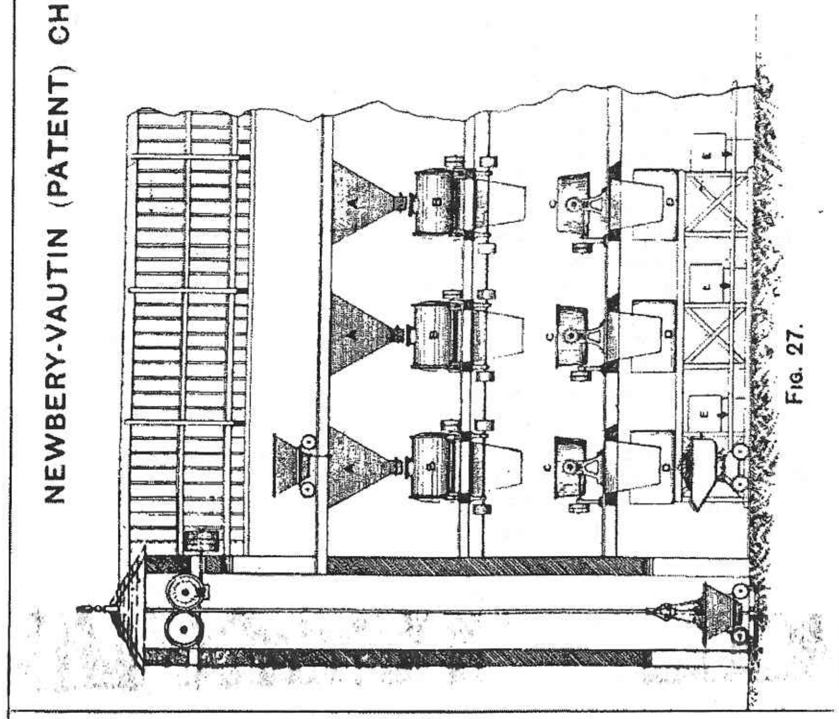

Fig. 27.

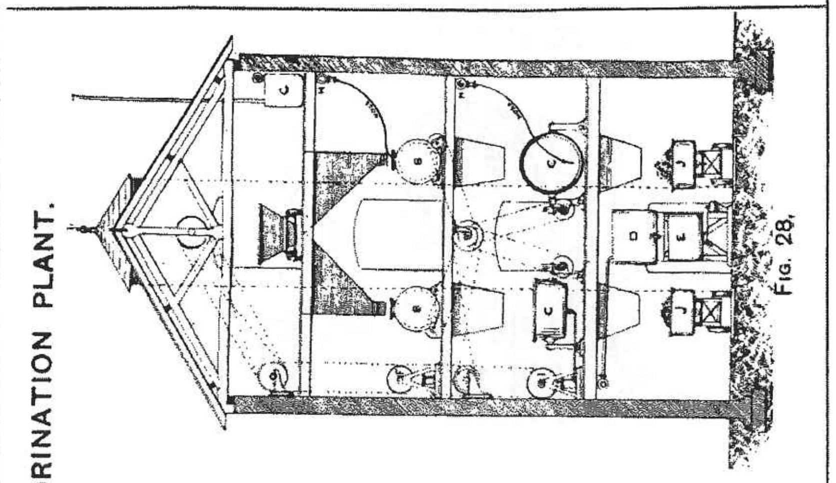

Fig. 28.

CHLORINATION PLANT.

The great success which attended the introduction of the Newbery-Vautin (patents) system of gold extraction by chlorination has induced us to become licencees for its manufacture, and we should not have considered our book complete if this important invention had been absent.

The plant necessary for the carrying out of the process will, from local conditions, vary, but to better describe it we have given in the engravings, Figures 27 and 28, end and side elevations of a *four*-barrel plant, and their accessories arranged within a building, the roasted ores coming into the chlorination mill in drop-bottom waggons, each of which has a capacity to fill one barrel. These waggons run on a tramway from the washing furnace (which may be of the rotary, reverberatory, or any other system), on to the power-lift at one end of the building; this raises the waggons and load on rails running over the hoppers, A, A; the principal other parts being chlorinating barrels, B, B, leaching-vat and filter, C, C, reservoir for the liquid from the filter, D, and the charcoal-collector, E. The hopper is fixed above the chlorination barrel; into this crushed and roasted ore or tailings are discharged. The barrel is made of iron, lined with lead, this again with prepared wood; it is sufficiently strong to bear a pressure of 100 lbs. to the square inch. In form it is cylindrical, and in the barrel are two doors directly opposite to each other. One door is sufficiently large to allow the pouring in of a stream of tailings or ore; the other is smaller, and is for the introduction of the compressed air. The barrels vary in size according to the quantity of ore required to be treated. The charge falls from the hopper through the larger door, when the required amount is poured in; chlorine-producing chemicals are added (commonly chloride of lime and sulphuric acid), and sufficient water is introduced so that the mass may assume a semi-liquid state. The cover is then screwed down, and the barrel is turned half round, so that the small valve is uppermost. To this is attached an indiarubber pipe, leading from an air-pump, F, F, and compressed air is forced in until a pressure of about 60 lbs. to the square inch is reached, then the valve is screwed down and the hose disconnected. By means of friction-wheels (on which the flanges of the barrel rest), the barrel is set revolving at a speed of about ten revolutions per minute; this brings the chloride of lime and sulphuric acid into combination, and produces the gas (Cl.), which, under the pressure now in the barrel, becomes liquid and mixes with the water, so that a strong solution of chlorine is in a continual state of agitation through the ore. The gold contained in the ore, from its contact with the chlorine solution, forms into a chloride of gold, which, being soluble in water, is rapidly absorbed by the liquid in the barrel. The time occupied in reducing the gold to this state varies according to the size of the gold grains, and the nature of the ore; with very fine gold one hour should be sufficient, but in cases of unusually coarse gold four hours may be necessary. The chlorinator being stopped, the hose is again attached, and the compressed air, mixed with gas, allowed to escape into lime-water tank, G, G, so as to prevent the inhalation of any disagreeable fumes. The large cover is then removed, and the barrel set revolving as before; at every downward turn it discharges a portion of its contents into a shoot leading to the leaching-vat, B, B, below. When almost all its contents are discharged, water is thrown in from the main, which, by the revolution of the vessel, is swirled around, thus completely washing into the filter all remaining solution. The filter, C, C, is an iron vessel lined with lead, with a double bottom; to the lower part of this, pipe is connected, leading to a vacuum pump, I, I. When the ore from the chlorinator has filled the filter, the air is drawn from between the double bottoms of the latter, which causes very rapid filtration. The filtered liquid is drawn off through a pipe into a vat; a continuous stream of water is kept playing upon the tailings in the filter, which, by the suction, is drawn through them, so that all the chlorides are washed out. To prevent any clogging of the material, the action of the exhaust-pump is made intermittent. The solution as it runs to the vat being continually tested, it is easy to know when the work is completed, then the water is cut off, and the pump stopped. The stuff in the filter is tipped into a truck, J, J, running on a line of rails below, by which means it is run to the tailing-heap.

The liquor drawn from the filter, C, C, contains gold in solution, lime, magnesia, copper, zinc, &c., according to the nature of the ore; also, in all instances, it retains a greater or less proportion of free chlorine. This being a deterrent to the decomposition of gold chlorides, it becomes necessary to dispel it, which is done by blowing air or steam through the liquid. If the water is entirely free from Cl. gas, decomposition of the gold chlorides occurs very rapidly when passed through charcoal. At the bottom of the vat, D, D, a trap, K, K, is fixed to run the liquid slowly through a filter of charcoal; contact with this material returns the gold chlorides to metal, they are so deposited amongst its pores and fibres, and on its surface. Copper, lime, magnesia, and zinc, are not touched by this reagent, so they pass through in a soluble state. The charcoal may be then burned in a crucible with borax, and the ingot of metal obtained. In some places it is difficult to arrange for a continual supply of charcoal; in such a case, the fine metallic gold may be dissolved from the charcoal by a weak solution of nitric acid and chloride. Such treatment very rapidly leaves the reagent clean—capable of being used again and again—and the gold is once more carried off in a soluble state by the liquor. The solution being now free of any substances but gold and aqua-regia, a steam or air blast is induced into it, so as to gather up and dispel the nitric acid, and leave the gold chlorides perfectly free; then a solution of sulphate of iron being added, the precipitation of the gold readily follows.

Any silver contained in the ore will be found in the filter as a chloride, and should the quantity prove sufficient, the tailings may be treated by hyposulphites in the ordinary way. All substances, soluble in H.Cl. acid, would pass through the charcoal untouched; lime and magnesia being of little value are generally run to waste; if the solution were passed over scrap iron, any copper contained in it would be deposited by natural chemical action.

The advantages claimed by this new method are as follows:—By treating ores with liquid Cl., resulting from the introduction of compressed air to liquefy the gas, the metals are rapidly absorbed in the barrel; the continual agitation whilst being chlorinated causes a friction between the grains of tailings, sand, and gold, which prevents any films of insoluble chlorides coating their surface, also grease, clay, sulphur, or even minute

air bubbles. The short duration of the process prevents the formation of hydrochloric acid, which would return the gold to its original state. Rapidity of filtration is, moreover, a substantial gain; the intermittent action of the vacuum pump adds an advantage even beyond the suction. The use of charcoal as a decomposing agent is obvious, as explained before. This part of the process cannot be patented, for over twenty years ago Mr. Newbery publicly advocated its use, and in some cases since then it has been employed. Our American cousins tried to patent the idea a few years ago, but they were too late in the field, its advantages being common property years before. Many persons object to chlorination, for the reason that the cost of roasting is heavy in some places. In the objection the main point is overlooked, namely: with a process which will extract practically all the gold in the ore, the increased return, in ninety-nine cases out of one hundred, amply repays the cost of roasting. It is doubtful whether there is another process in vogue which will, for the same cost, extract anything like the proportion of gold. In the writer's opinion, roasting is a decided advantage, even with the ordinary wet processes—with blanket, tables, and quicksilver. The reasons are these: There are few ores which will not assay much higher than the actual returns from the crushing mill; these findings are so very constant that they cannot be accounted for, by the chance of the samples assayed, being richer in ores than the whole body of stone. With amalgamation, very fine pulverising has always to be resorted to in order to obtain the most satisfactory results. The action of the heat in roasting leaves the stone in such a state, that when subjected even to moderate crushing, it splits into most minute particles along the lines of natural cleavage, whilst the foreign matter is either volatilised or assumes a more or less spongy condition. The ore will also come down more readily on to the tables, and so withstand better the rush of water, consequently, as a result, more nearly perfect amalgamation and less gold carried away by tailings. This can be very easily demonstrated. If a piece of clay be mixed thoroughly in a vessel with water, a large proportion of it will be held in suspension, and the liquor will be of a greasy, viscid nature. If an exactly similar piece of clay be burnt, as a brick, then subsequently pulverised and mixed with water, the solid matter will very rapidly fall to the bottom and leave the liquor in the vessel comparatively clear and clean; this experiment is so simple, that without difficulty anyone can try it. Chlorinise, to any extent without roasting, perfectly "free" ore; pulverise to a much greater degree of fineness than in ordinary practice, and amalgamate; then there will still be found a comparatively large proportion of gold in the refuse. Take the same ore, roast it, then treat it, and to all practical purposes the whole of the metal will thus be extracted. It requires no technical knowledge to readily understand why a gas or watery solution will prove itself a far more subtle amalgamating agent than quicksilver, for, by the very nature of the latter, it is unsuitable for finding its way in and out of minute crevices, yet, at the same time, when gold without any protecting film comes in contact with it, its value as an amalgamator is considerable; but in all systems of amalgamation, this very contact is the difficult point to produce.

It (the process) has been tried, and is in work at present in some of the principal mines in Victoria; at the United Pyrites Works, Sandhurst, where they thus treat ores of every possible character, from all parts of

Australia and New Zealand; at Malden, and at Walhalla, and at Cunningar, in New South Wales, where smelting works have been abandoned. At the famous Mount Morgan Mine (proper), in Queensland, it is exclusively used, after a trial and failure of many other systems; at Norton, Queensland, it is giving the greatest satisfaction; here, in London, Ravenswood "refractory ores" have been treated most successfully, after the system of local smelting works has been a failure. These Ravenswood ores are by Queenslanders considered to be the most refractory found anywhere in the colony.

The usual size of the barrels are for a charge of 25 cwt., and the leaching pan, &c., of equal capacity. This is found a convenient charge and the cost of the whole four-barrel plant, as shown in our engravings, Figures 27 and 28, with shafting, pumps, tanks, belts, lift, six waggons, three for the top floor, and three for spent ore, including all patentees' royalties, and packing and delivering same f.o.b., will be £1,750 Ape. Or, our price for a single barrel with driving gear, leaching-pan, or filter, tank for liquid from same, tank for absorbing gases from barrel, air-pump, vacuum-pump, shafting, pulleys, belts, pipes, one drop-bottom truck, one all-round tip waggon, small weigh-bridge for trucks, &c., complete, including royalties and delivery f.o.b. London, will be £420 (Bat).

From the two foregoing the cost of any size plant may be easily arrived at. Sometimes it is desirable, where the plant must be placed in light timber or iron sheds, that would be far too light to carry any machinery, to fit the whole plant up on a timber or iron framing, totally independent of the building which covers it, in fact it may, in some climates, be set to work in the open. Tenders and drawings for such an arrangement will be given on receipt of the necessary data as to quantity to be operated upon in a given time, and if framing is to be of wood or iron.

Where possible, samples of the ore to be treated should be sent, or of the concentrates or tailings. These will be carefully tested and reported upon, free of charge, if the plant be ordered; if not, a charge for testing concentrates of £2 will be made, and crushing from samples of ore, £5. These tests will be most carefully conducted by fully-qualified chemists and analysts, aided by the most complete plant and laboratory, specially erected by Messrs. Newbery & Vautin for the purpose.

GENERAL VIEW OF AERIAL ROPEWAYS.

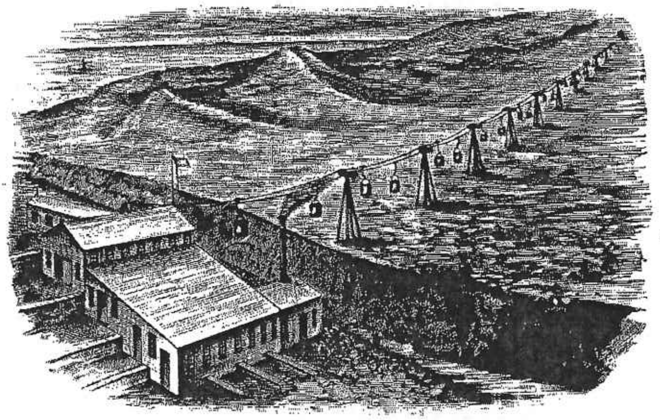

FIG. 29.

STATION AND TUBS OR SKIPS.

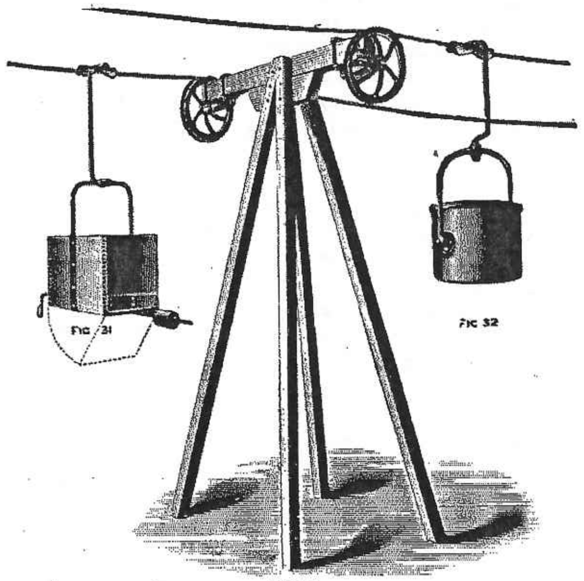

FIG 30

AERIAL ROPEWAYS.

The success which has attended the use of the system of aerial or overhead wire rope lines has long since passed the experimental stage, and it may safely be asserted that its use has been the primary means of entirely introducing or developing many industries that otherwise would have perhaps laid dormant or never existed, the means of a cheap transport through a difficult district, being sufficient to make a profit or loss on numerous commodities if not transported cheaply.

In mining districts this system of transport can often be employed with the greatest advantage, and we hope that the following description and data will be found sufficient to guide those desirous of availing themselves of its many advantages.

There are several systems in use, but we shall confine this description to the simple, single, endless rope, carrying and moving the load.

The points that should be attained in a good system are as follows :—

Working steep gradients.
Preventing the rope from leaving the sheaves.
Reducing the wear and tear of rope.
Working of long spans without injury to rope.
Reducing excessive wear on sheave journals.
Reducing the amount of power to a minimum.
Reducing the first cost of ropeway.

In the system we offer we claim to have embodied all these advantages.

In ordering or making inquiries the following data should be given :—

The length of line (accompanied, if possible, by a section of the ground, giving levels).
If the line can be taken direct from point to point, or if curves must be introduced ; if the latter they should be shown on the plan, the straight line should always be adopted if possible.
The difference of level from point to point.
The quantity of materials to be carried in a given time.
The kind of materials to be carried, with weight per cubic foot in the state it would be carried.
If the mean gradients are in favour of the load or against it.
If the country can supply the timber for the construction of the trestles, &c., and what is the nature of this timber.

The spans from trestle to trestle should be from 150 to 200 ft., and the rope carried by sheaves fixed on trestles about 15 ft. high, following as a rule the contour of the ground, the ends or bights of rope at the driving end pass half round a patent clip drum of suitable diameter placed horizontally in a timber frame and driven by means of steam or any other available motor, at a periphery speed of about 200 ft. per

minute, the other bight passing half round a clip pulley fitted to a tightening frame that will automatically keep the rope tight, and take up the " stretch " or expansion, or contraction of the rope. Our engraving, Figure 29, will convey a good general idea of the ropeway, while Figure 30 shows one of the intermediate stations in wood, and Figures 31 and 32 two of the usual forms of carriers or tubs.

Although we have mentioned 200 ft. as the span, where, from the nature of the ground, this span must be exceeded, spans up to 500 or 600 ft. can be worked, special provision being then made to distribute the increased strain of the rope over a large number of sheaves and bearing, at about its point of support.

Ropeways, having a mean falling gradient in favour of the loads of 10 deg., can be worked without a motor, the grip or clip drum being governed by a brake in the same manner as an ordinary self-acting tramway.

The buckets or tubs usually carry about 1 cwt. gross load, and can be made as Figure 32, requiring to be turned over by a lad, or self-acting on their discharge and closing, as Figure 31, and as with these tubs, if placed at 100 ft. apart, and travelling at 200 ft. per minute, 2 cwt. would be discharged per minute, or 120 cwt. per hour, and by increasing the number of buckets on the line this duty may be made 180 cwt. with tubs 75 ft. apart, or 224 cwt. with tubs 50 ft. apart ; and as this system of transport is free from all obstructions, it can be as easily run during the hours of darkness as by day, or independent of weather, it follows that if run 24 hours per day, a line such as above described will carry 288 tons, with a very small cost, say about 9d. to 10d. per ton, including all charges except power, which, in the case of a self-acting ropeway, would be nil.

The cost of materials for an overhead line may be taken at £1,100 to £1,500 per mile, including the whole of the machinery, ironwork, ropes, clip pulleys, castings, bolts, tubs, or buckets, at 100 ft. apart, and stations at an average of 100 ft. apart, buckets of either pattern Figure 31 or 32, but this estimate is for timber stations, which are not included, or any kind of masonry, stonework, or power to drive the rope (of course, if the line is a mean gradient of about 10 deg. in favour of the load, no power will be required), each additional support, or station costs £5 to £6 each, and the ore bucket for 1 cwt., £4 each ; the approximate weight per mile may be taken as 16 to 18 tons.

The tubs can be fitted with an automatic feeding apparatus to fill them as they pass the upper terminus, and discharge same at the lower stations, or *vice versá*, at an extra charge of about £60 to £70, exclusive of timber work in hopper.

By means of a slight modification, placing two or more hangers together with suitable cradle or tubs between them, timber, goods, or passengers may be easily conveyed.

WINDING ENGINES.

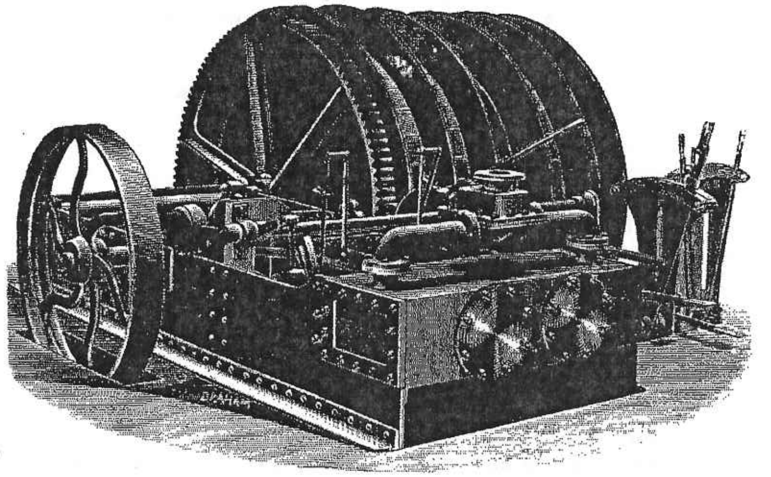

FIG. 24.

The variety of types and sizes of winding engines, applicable to all kinds of mining operations, would, if given in anything like detail, fill a section alone, and as it is our intention to treat this subject fully in a section under the title of " Hoisting Machinery," we shall here limit the subject to generally describing the various types most useful for mining purposes with the prices of same.

The various types we classify as under—

GEARED ENGINES.

FIG. 24.

DIRECT-ACTING ENGINES.

FIG. 25.

- Either vertical, horizontal, or diagonal.
- Single or double drums.
- ,, ,, cylinders.
- Drums inside or outside framing.
- ,, for round or flat ropes.
- Pumping as well as winding.
- With or without boilers.
- Engines and drums fitted on same frame.
- ,, ,, separate.
- ,, of the undertype class.
- Boilers of the tubular, locomotion, or Cornish type.
- Winding gear driven by belt from portable engine.
- Winding engines driven by compressed air or water power.
- Engines with composite drums of wood and cast iron.

DIRECT-ACTING WINDING ENGINE.

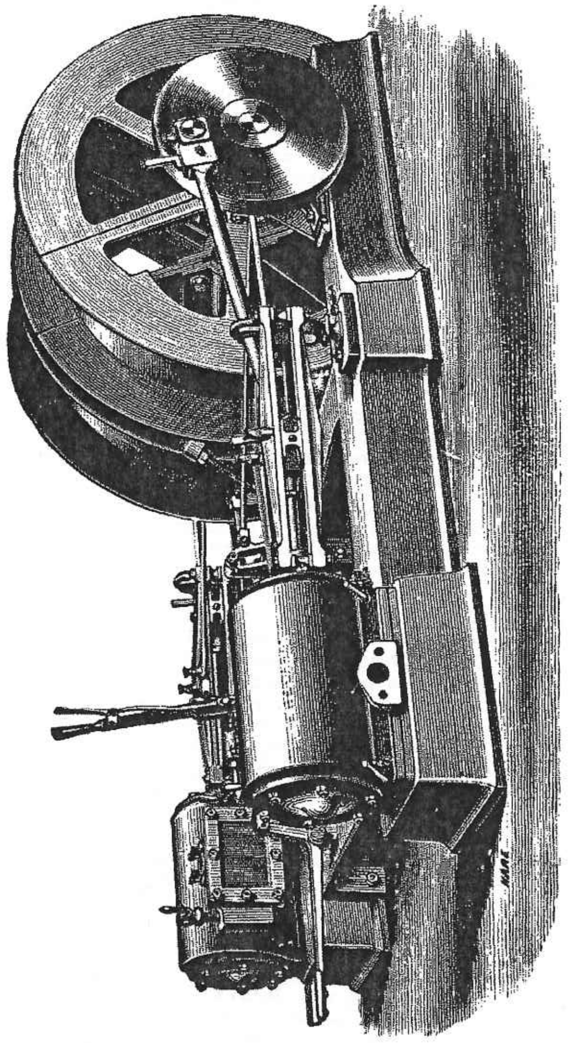

FIG. 25.

GEARED ENGINES.

FIG. 24.

DIRECT-ACTING ENGINES.

FIG. 25.

Engines with composite drums, cast and wrought iron.
Engines with wrought-iron or steel drums.
,, ,, cast-iron or steal gearing.
,, ,, conical drums.
Simple high pressure.
Compound or triple expansion.
Condensing, with either simple, compound, or triple expansion.
Winding engines, with patent clip pulley or twin drums, for inclines, overhead, wire rope, tramway, or power transmission.
Winding engines, driven by friction gear.
,, ,, with hand, foot, steam, or hydraulic brakes.
Winding engines, for common or machine chain.

When it is considered that either direct or geared type can, and often must, be fitted as described, or in any combination and of any power from about 10 to 1,000 indicated H.P., it will be obvious why we have here been compelled to limit the subject and price list.

We, of course, mean by the geared engine, any winding drums driven by a single or multiple set of gearing; and by the direct-acting winding-drums placed *directly* on the crank shaft of the engines without the intervention of any gear whatever.

Our illustration, Figure 24, gives what may be taken as a first-class type of a geared winding engine from a photograph of a 15 H.P., with a pair of high pressure cylinders, double independent outside drums, each drum having a central flange, so that double ropes can be used on each, in fact, the engine illustrated was for working two shafts each, with double roads. The engines were of 15 nominal H.P., having cylinders of 9 in. diameter × 14 in. stroke, case hardened link, reversing motions, steel crank, steel motion bars, steel framing of great depth, and everything possible to produce a high-class machine, and at the same time eliminating the great extra weight and risk of breakage if cast-iron bed plates, &c., were used, as it is too often the case with cheap and foreign-made machinery, the saving of freight alone to such places as the Transvaal, Gold Coast, &c., more than covering the difference of the first cost of the cheaper construction, while the risk of breakage is entirely removed, a condition of the utmost importance, especially for overland transport. The drums were each of 6 ft. diameter × 2 ft. wide, and were calculated to take 2,500 ft. of ⅝ in. diameter steel wire rope, all the levers for working the drum clutches, the foot brake levers, the reversing lever, and the steam regulator were all brought close together on to one bracket, the driver easily reaching and controlling all these levers without moving from his position in the least degree.

The engines were supplied with steam by a pair of locomotive boilers (each of ample power for the engines) placed side by side with the engines, the steam and all pipes being of wrought iron or copper, the boilers fed by means of steam duplex pump and an injector, either equal to full duty.

In the price lists following, boiler power only sufficient for engines is given, *not in duplicate*. The prices refer equally to drums, inside or outside the frames, and for any type of boiler, except Roots' patent, the extra price of which is given, and this extra price includes all the extras given in the detailed list, page 66, Figure 117.

CODE WORD	... ...	Ash	Bud	Cocoa	Drug
	NOMINAL HORSE-POWER	10	15	20	25
	Diameter and stroke of engine, in.	8 × 12	9 × 14	10 × 16	11 × 18
	Usual diameter of drums ... ... feet	4	5	5½	6
	Approximate speed of rope for geared engine ... ... ,,	200	250	300	350
	Ditto for direct-acting engine ,,	1,200	1,500	1,700	1,900
	Load fitted with geared engine, cwt.	15	25	30	40
	Ditto with direct-acting ,, ,,	3	4½	6	7½
Ape	Price of geared engine	£400	£525	£625	£720
Bat	,, direct-acting engine	£380	£475	£575	£660
Chick	Extra price with "Roots" boiler ...	£90	£100	£115	£140
Dove	,, cost for wood-burning locomotive boiler	£15	£22 10	£30	£37 10
Ewes	Ditto for two feeds to boiler	£18	£20	£22	£25
	Approximate measurement, cub. ft.	670	825	950	1,100
	,, weight ... ... tons	10	12	14	16

CODE WORD	... ...	Elms	Fir	Grape	Hazel
	NOMINAL HORSE-POWER	30	35	40	50
	Diameter and stroke of engines, in.	12 × 20	13 × 20	14 × 22	16 × 24
	Usual diameter of drums ... ... feet	6	6	6½	7
	Approximate speed of rope for geared engine ... ... ,,	400	400	450	500
	Ditto for direct-acting engine ,,	2,000	2,000	2,200	2,500
	Load fitted with geared engine, cwt.	45	50	55	60
	Ditto with direct-acting ,, ,,	9	10	11	12
Fox	Price of geared engine	£800	£900	£990	£1,080
Goats	,, direct-acting engine	£725	£820	£900	£990
Heron	Extra price with "Roots" boiler ...	£165	£190	£210	£230
Ibis	,, cost for wood-burning locomotive boiler	£45	£52 10	£60	£75
Jay	Ditto for two feeds to boiler	£27 10	£30	£35	£40
	Approximate measurement, cub. ft.	1,250	1,400	1,550	1,800
	,, weight ... ... tons	19	22	25	30

It may be taken that the duty given for the engines is low, so as to leave ample for friction of ropes, pulley, &c. It may be also taken that these prices apply equally to the undertype, diagonal, or vertical, and all for double drums; the cost of single drums would be about 3 per cent. less. The two largest sizes will be supplied with two boilers of proper capacity. Compound engines may be taken at 10 per cent. above the list, duty for duty. Packing, 3 per cent. extra.

Diameter of drums and speed of gear will be altered within any reasonable limit without extra charge.

We give these prices, which are useful to facilitate calculation to those abroad, but as we have pointed out already, the variations are so wide, that where possible, particulars should be given, and definite tenders obtained; the data that should accompany such enquiries should be as follows:—

Nature of work the engine is to be employed for.
If single drum, working up and down ropes.
If double ,, ,, ,, ,,
If each ,, will work ,, ,,
Which class of boiler is considered most desirable, with undertype engines or separate frame, as Figure 24.
Nett quantity of materials to be raised in a given time.
If vertical shaft or inclined—if latter give angle.
Depth of vertical or length of incline shaft or incline way.
Kind of tubs or waggons to be used, with capacity and weight of materials per lift, and weight per cubic foot.
Kind of rope it is intended to use.
Kind of fuel available, and intended to be used.
If pumping arm is to be fitted or not.
If high pressure or compound.
If condensing, jet, or surface.
If geared or direct acting.

On the receipt of such particulars, estimates and drawings will be furnished for winding engines of any capacity, together with all their accessories, such as the complete pit-head frames, all of iron, with their pit-head pulleys, landing dogs, indicator, patent apparatus to prevent overwinding—or the whole of the ironwork will be supplied for the construction of the pit head frame in timber, together with a fully detailed and dimensioned tracing to guide the mechanics in its construction.

Cages, with single or double decks, made entirely of wrought iron or steel, and fitted with most approved form of safety gear catches to prevent the cages falling in the event of accident to the ropes.

Winding engines for under-ground haulage are of the same type as Figure 24, but are made even more compact, the drums and gearing being throughout of steel, and the rope drums made narrow, but deep between the flanges, taking a greater number of laps or coils, one on the other, and thus considerably reducing the diameter and width of the drums, and the consequent length and width of the frames. The practice to take many coils one on the other is not quite so good as a single coil, but to reduce the size and weight of engines that have to be placed underground it must often be resorted to, and, at the same time, reduce the size of heading necessary to contain the engine.

For working under-ground inclines, the patent clip drum can often be best employed with wire endless or tail ropes, or they can be fitted with special spocket wheels to suit any form of chain. Air can be employed to drive such engines as well as by steam, or specially constructed engines to be driven by water power. In some cases, where steam is employed, the difficulty of getting rid of the exhaust steam may be avoided by the use of a jet or surface condenser, at the same time increasing the efficiency of the engines.

PRIME MOVERS OR MOTORS.

To render this section complete in itself, we annex a few general remarks, illustrations, and prices of engines, boilers, turbines, and water wheels, but this subject alone would require a large section to, in any way, fully treat it. We have, therefore, been here compelled to restrict it, but it will, in the section specially devoted to "Prime Movers," be extended and made complete.

The choice of a motor for driving mining machinery, or in fact any machinery, should receive careful consideration before decision, such as the means of transport, nature of fuel, quantity and quality of water at command, &c., cost of collecting, conveying, or storage of water, constancy of supply during all seasons of the year, &c.

It must not, for instance, be assumed that, even where water power is available, that it is necessarily the cheapest power. We have known people to come without proper consideration to this conclusion, even acting under the advice of engineers of great repute, that have found at last to their cost, that the ordinary percentage on the outlay on necessary works to obtain the required supply came to more than would provide coal for the total supply of a steam engine of equivalent power that could be worked continually, while the water power was subject to stoppage two to three months each year from floods, and an equal time from drought.

For difficult overland transport the use of steel pipes for turbines should be recommended, as also for their casings; and for boilers, the sectional improved "Roots," Figure 117, page 66. This class of boilers are good boilers for wood burning, the grate being independent of the generating portion of the boiler, can be proportioned for this purpose. High pressures with compound engines should always be selected where fuel is dear or water scarce, and, although not generally known or used, an evaporative surface condenser can be applied to engines that only require the same amount of water that would be required for an ordinary high-pressure engine, and would give an increase of power of 25 to 30 %. This form of condenser is perfectly simple, not likely to get out of order, and easily transported. Many persons think that compound engines are complicated; this is an error, a compound engine is no more so than a high-pressure double cylinder engine of equal power, while it will not consume more than about half the weight of steam, power for power.

We have selected in the following pages, a few types of the plain high-pressure engine, compound tandem, and condensing, with boilers of Cornish, Lancashire, sectional, vertical, and locomotive construction, turbines, and water wheels, but we can supply engines of the compound side-by-side type on wrought-iron framing, specially built for overland transport in sections, engines fitted with the Colmann valve gear, equal to the Corliss or any other form of valve gear, boilers fitted with fuel economizers, water heaters of the most approved form that can be readily cleaned and scaled, driving gear of iron or steel with spur, bevel, or helical teeth, rope driving gear, &c.

HORIZONTAL HIGH-PRESSURE ENGINES.

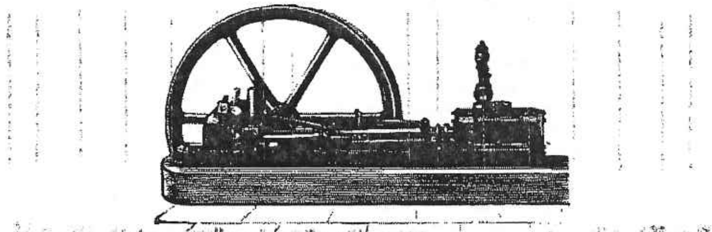

Fig. 104.

Figure 104 represents a horizontal high-pressure steam engine of the "flat bed" or Lancashire type, in which are embodied all the most recent improvements. The bed-plate runs the full length of the engine; it has double slides, fitted with cast-iron slipper slide blocks, steel cross-head and shaft, piston-rod, valve-rod, metallic piston, and hammered wrought-iron crank-shaft. The crank-shaft bearings are of gun-metal, and both ends of the connecting-rod are of forged wrought iron fitted with gun-metal bearings. These engines are fitted with patent governors, feed-pump fitted with brass seatings, valves, eccentric straps, &c. The fly-wheels are of ample weight, turned on face and edges, and a wall box with double brasses is supplied to carry outer end of crank shaft. This type of engine can be fitted with condenser, as Figure 105, and with

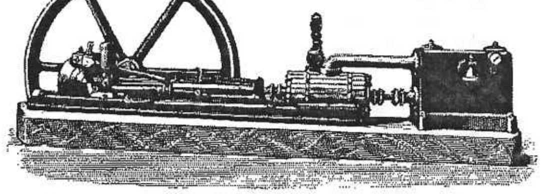

Fig. 105.

variable expansion by hand or with automatic variable expansion gear, and can be made either right or left hand without extra cost. When these engines are fitted with automatic expansion gear, the governor used is then of the high speed "Porter" type, the large size governors having a dash foot, and the kind of expansion valve we recommend is the form known as "Rider's" with several important improvements; if desired, however, we will, at the prices quoted, fit the engines with either the "Myer's" or "Hartnell" type of valve. All the engines in the subjoined list can be made double cylinder or compounded, and their prices arrived at approximately for compound or condensing in the following manner:— Say it is desired to have a compound engine, 12 in. × 18 in. × 32 ft., of the

---

side-by-side type, non-condensing; take the 12 in. × 20 in. with automatic expansion, £133, and the 18 in. × 32 in., £240. Total, £373. The 12 in. engine would, of course, be made the same stroke as the 32 in., the extra cost of this being provided by the saving in the fly-wheels and outer bearings. If it is desired to have the same engine condensing, add to £373 the cost of condenser found in the column for 35 H.P. 18 in. × 32 in., £65, or a total for the compound condensing engine of £373 + £65 = £438, and its *nominal* power may be taken approximately at the power given for the low-pressure cylinder, viz. 35 H.P. without condenser, and one-third more with, and will indicate with usual boiler-pressures three times its nominal.

Great care is given to the lubrication of all parts. Sight-feed lubricators are fitted to the cylinders, and foundation bolts and plates are included in the prices subjoined.

CODE WORD	... ...	Ash	Bud	Cocoa	Drug	Elms
	NOMINAL HORSE-POWER ...	8	10	12	14*	20*
	Diameter of cylinder, inches	9	10	11½	12	14
	Length of stroke ... „	16	18	[illegible]	20	24
	Revolutions per minute ...	125	120	120	110	100
Ape	Price—Figure 104...	£72	£90	£100	£115	£140
Bat	Extra price for expansion valve	£6	£75	£8	£8 10	£9 10
Chick	Price, with automatic expansion	£84	£104	£116	£133	£160
Dove	Price, with condenser, Figure 105	£28	£30	£33	£35	£50
Ewes	Price, with feed-pump... ...	£4	£5	£5	£6	£7
	Weight, engine only cwt.	22	30	33	35	68
	„ fly-wheel ... „	12	18	20	25	30
	„ condenser „	8	8	8	12	15

CODE WORD	... ...	Fir	Grape	Hazel	Ilex	Jam
	NOMINAL HORSE-POWER ...	25*	35*	40	40	60
	Diameter of cylinder, inches	16	15	20	20	24
	Length of stroke ... „	28	32	36	42	42
	Revolutions per minute ...	75	70	65	55	55
Fox	Price—Figure 104...	£180	£240	£300	£350	£420
Goats	Extra price for expansion valve	£10 10	£12	£15	£20	£20
Heron	Price, with automatic expansion	£202	£265	£330	£390	£460
Ibis	Price, with condenser Figure 105	£58	£65	£75	£85	£90
Jay	Price, with feed-pump ...	£8	£10	£12	£14	£15
	Weight, engine only cwt.	90	120	180	220	250
	„ fly-wheel ... „	38	55	65	80	100
	„ condenser „	21	26	32	35	40

The sizes marked with a * can be supplied with longer cylinders at a small extra cost.
Packing for shipment, from 3 to 5 per cent. extra

HORIZONTAL TANDEM COMPOUND CONDENSING ENGINE.

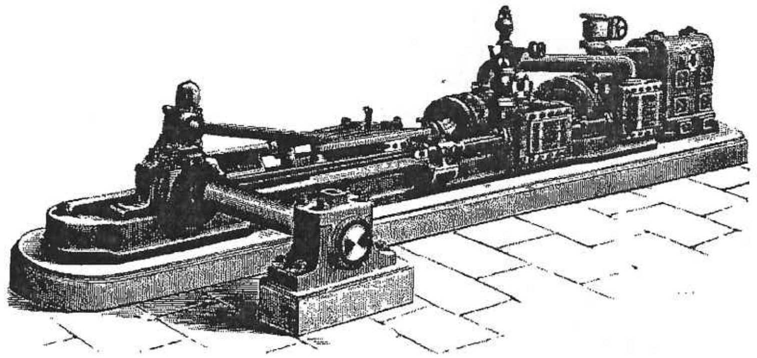

FIG. 100.

The tandem engine illustrated above may be considered the simplest form that can well be devised for a compound condensing engine, having but one crank, one connecting-rod, one piston-rod, one bed-plate and set of guides; it occupies but little ground area, and its first cost is also less than any other type, while its efficiency for ordinary purposes, for small and moderate sizes, is quite equal to the double engines, a rather heavier fly-wheel being provided to equalize the motion. (This fly-wheel has been unfortunately omitted from our engraving through not being on when the engine was photographed). When desired, the jet condenser shown in the woodcût may be replaced by a neat form of surface-condenser, mounted on the air and circulating pump, at an extra cost, and this form of condenser should be adopted where the water is bad or where boilers of the multitubular kind are in use.

CODE WORD	... ...	Ash	Bud	Cocoa	Drug	Elms
	NOM. HORSE-POWER ...	20	25	35	45	60
	Diam. and stroke, in.	9 × 15 × 20	10 × 16 × 24	12 × 18 × 24	14½ × 22 × 28	16 × 26 × 36
	Revolutions per minute	120	100	100	90	80
Ape	Price of engine with ordinary expansion gear	£200	£325	£355	£400	£560
Bat	Price with automatic expansion gear ...	£220	£350	£380	£430	£590
Chick	Extra for feed-pump ...	£6	£7	£8	£9	£12
	Weight of engine, cwt.	40	70	95	120	180
	" fly-wheel "	30	38	40	50	75

Packing for shipment, 3 to 5 per cent. extra.

ALCOTT'S TURBINE.

The turbine wheel, Figure 37, will be found to give a very high efficiency, and at the same time it is designed to combine great compactness, and avoid the use of rods, levers, joints, bolts, innumerable in some forms of turbine wheels.

This form of wheel may not be quite perfection, but it certainly combines many valuable features. The outer casing is fixed, it can be worked under variable quantities of water, and yet remain perfectly balanced, the regulation not breaking the column or changing the current's relative angle on the buckets, or in any way checking the velocity. It will work with equal efficiency from full power down to one-third, and this variation is made by simply giving a turn of the hand-wheel rod leading to the small coupling shown on the side of the casing.

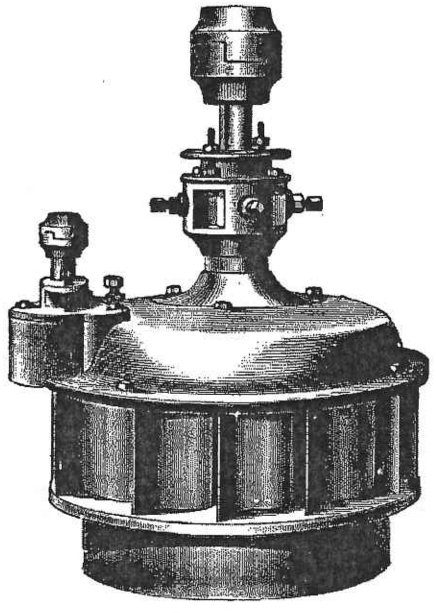

FIG. 37.

It is well known that some turbines, although giving good results at full power, give but poor efficiency at *partial gate* or low power, but it is claimed that this form gives quite equal results under these conditions.

The greatest care is taken throughout in its construction and the materials employed.

The following tables contain the sizes of wheels 6 in. to 24 in., but they can be supplied of the same design up to any size, and the list also gives speeds and quantities of valve under different heads; intermediate heads, &c., may readily be approximated from them. Prices for wheels and their casings are also given, the wheels being neatly fitted into same, and a flange provided to bolt the supply pipe to, and these are strongly recommended to be ordered with the wheel, facilitating the erection, and ensuring often better results than can be secured by using a timber home-spun casing, often leaky and imperfect with its connections. The wheels will work in the tail-race water without loss of efficiency, except that due to head. They can be made to run in either direction, but unless ordered specially, they are sent to run with the sun.

Table giving Diameter of Wheel, cubic feet of Water per Minute, Horse-power, Number of Revolutions under Head of 10ft. to 90ft. high, with Prices of Wheels and Cases or Flumes.

CODE WORD		... ...	Ash	Bud	Cocoa	Drug	Elms	Fir	Grape	Hazel	Ilex	Jam	Kernel	Lichen	Mahogany
		HEAD OF WATER, feet	10	15	20	25	30	35	40	45	50	60	70	80	90
Ape Bat	Diam., 6 inches	Cub. ft. of water per min.	42	51	59	66	72	78	83	84	89	98	105	112	119
		Horse-power	0·65	1·19	1·83	2·56	3·35	4·23	5·15	6·2	7·2	9·5	12·1	14·8	17·6
		Revolutions per minute	640	784	905	1,012	1,109	1,198	1,280	1,606	1,694	1,856	2,004	2,144	2,270
		Diameter of pipes, in.	12	—	—	—	—	—	—	—	—	—	—	—	—
		Price of wheel	£25	—	—	—	—	—	—	—	—	—	—	—	—
		„ casing	£10	—	—	—	—	—	—	—	—	—	—	—	—
Chick Dove	Diam., 7½ inches	Cub. ft. of water per min.	65	80	92	103	113	122	130	152	159	174	189	202	214
		Horse-power	1·01	1·86	2·85	3·99	5·25	6·62	8·06	10·9	12·4	17·0	29·7	26·7	31·1
		Revolutions per minute	512	627	724	810	887	958	1,024	1,212	1,277	1,400	1,511	1,618	1,714
		Diameter of pipes, in.	12	—	—	—	—	—	—	—	—	—	—	—	—
		Price of wheel	£28	—	—	—	—	—	—	—	—	—	—	—	—
		„ casing	£11	—	—	—	—	—	—	—	—	—	—	—	—
Ewes Fox	Diam., 9 inches	Cub. ft. of water per min.	94	115	133	149	163	176	188	190	200	220	237	254	269
		Horse-power	1·46	2·67	4·12	5·77	7·58	9·55	11·66	14·4	17·0	22·1	28·0	34·0	41·0
		Revolutions per minute	437	523	604	675	739	799	854	1,058	1,116	1,220	1,318	1,408	1,495
		Diameter of pipes, in.	14½	—	—	—	—	—	—	—	—	—	—	—	—
		Price of wheel	£30	—	—	—	—	—	—	—	—	—	—	—	—
		„ casing	£12	—	—	—	—	—	—	—	—	—	—	—	—
Goats Heron	Diam., 10½ inches	Cub. ft. of water per min.	128	157	181	203	222	240	256	258	272	298	323	344	364
		Horse-power	1·98	3·65	5·61	7·87	10·32	13·02	15·87	18·5	21·6	29·0	36·7	45·0	53·6
		Revolutions per minute	366	448	517	578	634	684	732	924	974	1,068	1,152	1,234	1,308
		Diameter of pipes, in.	14½	—	—	—	—	—	—	—	—	—	—	—	—
		Price of wheel	£33	—	—	—	—	—	—	—	—	—	—	—	—
		„ casing	£13	—	—	—	—	—	—	—	—	—	—	—	—

Table giving Diameter of Wheel, cubic feet of Water per Minute, Horse-power, Number of Revolutions under Head of 4ft. to 40 ft. high, with Prices of Wheels and Cases or Flumes.

CODE WORD		... ...	Ash	Bud	Cocoa	Drug	Elms	Fir	Grape	Hazel	Ilex	Jam	Kernel	Lichen	Mahogany
		HEAD OF WATER, feet	4	5	6	7	8	9	10	15	20	25	30	35	40
Ape Bat	Diam., 12 inches	Cub. ft. of water per min.	106	118	130	140	150	159	167	205	236	264	290	313	334
		Horse-power	0·66	0·89	1·21	1·52	1·86	2·22	2·59	4·78	7·32	10·23	13·48	16·98	20·71
		Revolutions per minute	202	226	248	268	286	304	320	392	453	496	554	599	640
		Diameter of pipes, in.	17	—	—	—	—	—	—	—	—	—	—	—	—
		Price of wheel	£35	—	—	—	—	—	—	—	—	—	—	—	—
		„ casing	£15	—	—	—	—	—	—	—	—	—	—	—	—
Chick Dove	Diam., 15 inches	Cub. ft. of water per min.	165	185	202	219	234	248	261	320	370	413	453	489	523
		Horse-power	1·02	1·43	1·88	2·38	2·90	3·47	4·05	7·44	4·47	16·00	21·07	26·53	32·43
		Revolutions per minute	162	181	198	214	229	243	256	314	362	405	444	479	512
		Diameter of pipes, in.	17	—	—	—	—	—	—	—	—	—	—	—	—
		Price of wheel	£40	—	—	—	—	—	—	—	—	—	—	—	—
		„ casing	£19	—	—	—	—	—	—	—	—	—	—	—	—
Ewes Fox	Diam., 18 inches	Cub. ft. of water per min.	238	266	292	315	337	357	377	461	533	596	652	704	714
		Horse-power	1·47	2·06	2·72	3·42	4·18	4·98	5·81	10·72	6·52	23·09	30·32	38·19	39·84
		Revolutions per minute	135	151	165	179	191	202	213	262	302	337	370	399	405
		Diameter of pipes, in.	24	—	—	—	—	—	—	—	—	—	—	—	—
		Price of wheel	£50	—	—	—	—	—	—	—	—	—	—	—	—
		„ casing	£24	—	—	—	—	—	—	—	—	—	—	—	—
Goats Heron	Diam., 24 inches	Cub. ft. of water per min.	423	473	518	560	598	635	669	819	946	1,058	1,159	1,251	1,338
		Horse-power	2·62	3·67	4·81	6·08	7·41	8·86	10·37	19·04	29·33	41·00	53·89	67·87	82·95
		Revolutions per minute	101	113	124	134	143	152	160	196	226	253	277	299	320
		Diameter of pipes, in.	30	—	—	—	—	—	—	—	—	—	—	—	—
		Price of wheel	£66	—	—	—	—	—	—	—	—	—	—	—	—
		„ casing	£32	—	—	—	—	—	—	—	—	—	—	—	—

WATER WHEELS.

The annexed engraving, Figure 36, illustrates a good form of water wheel, constructed chiefly of wrought iron, which renders it light for transport, easy for erection, and non-liability to breakage.

They are constructed on the best known principle and will give out a very high efficiency, and where the necessary fall and quantity of water is available, are the best motors that can be had for driving all kinds of mining machinery. From their low speed they can frequently be coupled up direct on to the cam shaft, without the intervention of any gearing whatever.

These wheels are fitted with segmental driving gear that can be fixed on either side of the wheel; shrouded or ordinary driving wheel can be placed on an extension of the shaft. The prices include this segmental ring and pinion to suit, and the prices of the sluice gear include iron staple posts & forehead piece, bottom plank, wrought or worked oak sluice board, iron racks, purchases, &c., for same, for leading into mill building. In ordering wheels, the quantity of water per minute should be given, head of water, width between walls, if to be driven by the segmental gear, and from which side, left or right, standing at head of race looking at wheel, or length of shaft required beyond wall, for taking other form of driving gear; and rough sketch, with dimension showing relative position of wheel to other machinery. Our list gives sizes from 10 ft. to 30 ft. diam. × 2ft. to 8 ft. wide, quantity of water required, and number of revolutions; the intermediate sizes may be arrived at approximately from this data, as also the prices.

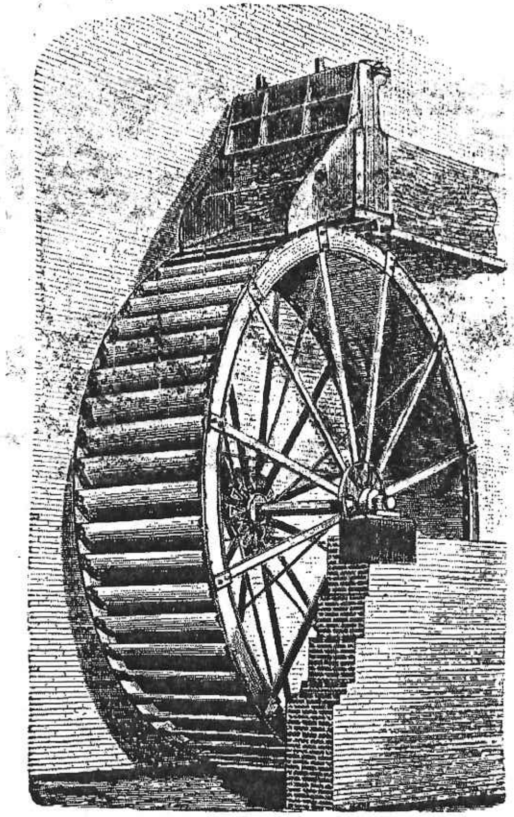

FIG. 36.

☞ This type of wheel is suited to breast or overshot falls; the undershot wheel will be rather less in cost, and buckets of a different construction.

ERRATA.

Page 63.—For dimensions of Head and Diameter in first two vertical columns, instead of "inches" read "feet."

Table giving approximate data of Water Wheels 10 ft. to 30 ft. diameter × 2 ft. to 8 ft. wide.

CODE WORD	...	...	... ...	Ash	Bud	Cocoa	Drug	Elms	Fir
			WIDTH OF WHEEL, ft.	2	3	4	5	6	8
Ape Bat	Head, 11 inches	Diam., 10 inches	Cub. ft. water per min.	264·0	453·32	650·66	847·96	1045·24	1452·0
			Horse-power	3·5	6·08	8·66	11·24	13·82	19·01
			Revolutions per min. .	12·3	12·3	12·3	12·3	12·3	12·3
			Price of wheel	£51	£63	£74	£85	£97	£119
			„ sluice gear ...	£5	£7	£9	£12	£14	£18
			Approx. weight, cwt.	42	57	71	85	100	128
Chick Dove	Head, 13 inches	Diam., 12 inches	Cub. ft. water per min.	265·71	459·64	658·91	858·14	1057·33	1448·5
			Horse-power	4·14	7·25	10·36	13·47	16·58	22·79
			Revolutions per min. .	10·5	10·5	10·5	10·5	10·5	10·5
			Price of wheel	£58	£71	£84	£96	£100	£134
			„ sluice gear ...	£5	£8	£10	£13	£15	£20
			Approx. weight, cwt.	54	72	90	108	126	161
Ewes Fox	Head, 15 inches	Diam., 14 inches	Cub. ft. water per min.	267·43	465·97	667·17	868·32	1069·43	1445·1
			Horse-power	4·76	8·39	12·02	15·65	19·28	26·57
			Revolutions per min. .	8·8	8·8	8·8	8·8	8·8	8·8
			Price of wheel	£70	£85	£100	£115	£129	£159
			„ sluice gear ...	£6	£8	£11	£13	£16	£21
			Approx. weight, cwt.	66	88	109	130	152	195
Goats Heron	Head, 17¼ inches	Diam., 18 inches	Cub. ft. water per min.	269·14	472·30	675·43	878·51	1081·52	1441·7
			Horse-power	5·40	9·55	13·70	17·85	22·0	30·35
			Revolutions per min. .	7·4	7·4	7·4	7·4	7·4	7·4
			Price of wheel	£82	£99	£116	£133	£150	£184
			„ sluice gear ...	£6	£9	£12	£14	£17	£22
			Approx. weight, cwt.	78	103	128	153	178	228
Ibis Jay	Head, 21½ inches	Diam., 20 inches	Cub. ft. water per min.	280·125	484·96	691·94	898·88	1105·72	1494·0
			Horse-power	7·62	13·22	18·82	24·42	30·02	41·25
			Revolutions per min. .	5·5	5·5	5·5	5·3	5·5	5·5
			Price of wheel	£112	£135	£157	£180	£202	£247
			„ sluice gear ...	£8	£10	£13	£16	£19	£24
			Approx. weight, cwt.	102	134	166	198	230	294
Kraken Locust	Head, 25½ inches	Diam., 24 inches	Cub. ft. water per min.	287·625	497·61	708·45	919·24	1129·91	1534·0
			Horse-power	9·19	15·82	22·45	29·08	35·71	48·98
			Revolutions per min. .	4·6	4·6	4·6	4·6	4·6	4·6
			Price of wheel	£141	£169	£200	£225	£253	£309
			„ sluice gear ...	£9	£12	£15	£18	£21	£27
			Approx. weight, cwt.	125	165	204	243	282	360
Mongoose Nightjar	Head, 31¾ inches	Diam., 30 inches	Cub. ft. water per min.	300·0	516·6	733·2	949·8	1166·4	1600·0
			Horse-power	12·0	20·53	29·06	37·59	46·12	63·21
			Revolutions per min. .	3·1	3·1	3·1	3·1	3·1	3·1
			Price of wheel	£185	£221	£259	£293	£329	£400
			„ sluice gear ...	£10	£14	£17	£20	£24	£80
			Approx. weight, cwt.	160	210	260	310	360	460

LANCASHIRE AND CORNISH BOILERS.

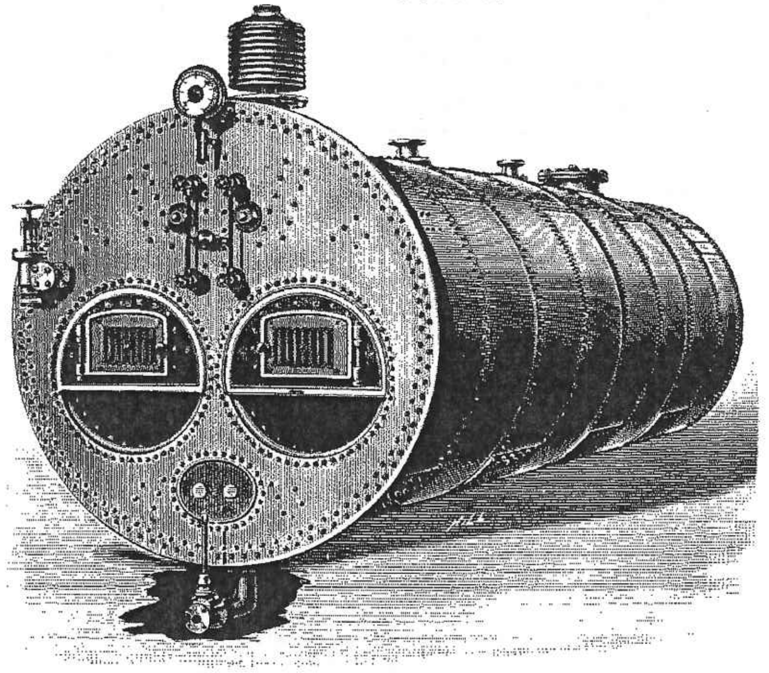

FIG. 35.

The "Lancashire" boilers have two flues or furnaces, and the "Cornish" one flue or furnace. The former is recommended for boilers above 20 H.P., and the latter for powers of 20 H.P. and below. All boilers are of first class construction, designed for a safe constant working pressure of 80 lbs. per square inch, and tested to 140 lbs. per square inch.

The flues are made of the best selected mild steel of welding and flanging quality, the shells and ends of the best Staffordshire or South Yorkshire of approved brand, the longitudinal seams of the flues welded, and transverse seams flanged by machinery, forming anti-collapsive joints, all the edges of the plates and the corners planed, and all longitudinal seams *double rivetted.*

The Lancashire boilers are fitted with raised cast steel manhole frames or rings and lids having faced joints, and faced branches for the reception of the valves.

The furnace fittings consist of wrought-iron furnace fronts and screens, cast-iron doors with perforated baffle plates, bearers, dead plate, and fire bars, polished brass moulding to cover joint of furnace front to boiler flue, and an improved ventilating air slide to doors for smoke consuming and prevention.

The steam mountings or fittings consist of suitable stop-valve of proper diameter for the size of boiler, with internal anti-priming pipe, lever safety-valves and check or back pressure feed-valve, steam pressure gauge, water-gauges, blow-off cock, fusible plug, damper, and frame, with pulley-chain and balance-weight, flue doors and frames, and all the necessary bolts for fixing the valves, &c., to the boiler.

CODE WORD	... ...	Ash	Bud	Cocoa	Drug	Elms	Fir
	DESCRIPTION OF BOILERS ...	CORNISH BOILERS			LANCASHIRE BOILERS		
	Nominal horse-power	10	15	20	30	40	50
	Length ... ... feet	12	14	16	20	24	30
	Diameter ... ... ,,	4	4¾	5	6	7	7
	Diameter of flues ... ... ,,	2	2½	2½	2¼	2¾	2¾
	Thickness of shell ... inches	⅜	⅜	⅜	7/16	½	½
	,, flues ... ,,	⅜	⅜	⅜	⅜	⅜	⅜
	,, ends ... ,,	½	½	½	½	9/16	9/16
Ape	Price of boiler only	£65	£80	£90	£140	£200	£240
Bat	,, furnace fittings	£6	£8	£10	£16	£18	£20
Chick	,, steam ,, ...	£20	£22	£25	£32	£35	£40
Dove	,, conical cross-tube at each	£2	£2	£2	£2	£2	£2
	Approximate weight ... cwt.	60	90	110	200	250	300

Our engraving is shown with a Cowburn's patent dead weighted safety-valve, which can be supplied at a small additional extra cost to the above prices, and a scum pipe and valve at the opposite side of the boiler-front to the feed-valve at a cost of about £3 to £5 per boiler.

Connections between engine and boiler, if placed near to each other, including steam-pipes, pump-pipes, and exhaust, may be had at about £1 per horse-power. Condensing engines about £1 10 per horse-power.

Any other sizes of boilers will be quoted for on application, but those given above are good proportion, and by the addition of the conical cross water-tubes in the flues, the powers of the boilers are increased about one horse-power nominal per tube.

For localities where brick chimneys cannot be easily or cheaply constructed, we can supply chimneys built up of wrought iron in slightly conical lengths, so that they will pack or nest one within the other, and reduce the measurement of the several lengths to that of the largest, equalling about the dead weight; these chimneys have a strong cast-iron base, wire rope guys, and attachments to chimney at last joint flange, and anchorage plates and stretching screws, prices as under :—

CODE WORD	... ...	Grape	Hazel	Ilex	Jam	Kernel	Lichen
Ewes	Horse-power of boiler	10	15	20	30	40	50
	Price of chimney ...	£20	£30	£40	£50	£60	£70
	Approx. weight cwt.	20	30	40	60	70	80

The boilers are delivered f.o.b. London, except in the case of special cranage for the heavy boilers.

IMPROVED "ROOTS" BOILER.

Where overland transport is difficult and costly, great advantage is derived from the use of the tubular boilers, Figure 117, the largest type of which can, if necessary, be shipped in pieces weighing from 1½ to 2 cwt. They are economical in working, rapid in circulation, suitable for high pressures, and are practically safe from serious disaster in the event of explosion. They can be readily put together at destination, by an ordinary mechanic with only the use of a set of spanners. All parts are interchangeable, and each boiler is supplied with all the usual mountings, fittings, and ordinary fire grate, &c., a separate price being given for feed-pump and connections, iron casing and wrought-iron chimney, fire bricks, clay and quarries. The metallic joints are indestructible, and are a great improvement on the old form of perishable packings. They admit of unequal expansion of the tubes, thus preventing any leakage. They are easily disconnected and re-made, and admit of pressures hitherto impossible in this class of boiler. Each boiler is tested by hydraulic pressure to 350 lbs. per square inch. The receiver, when possible, is sent in one piece, but it can be divided into two or three parts if required.

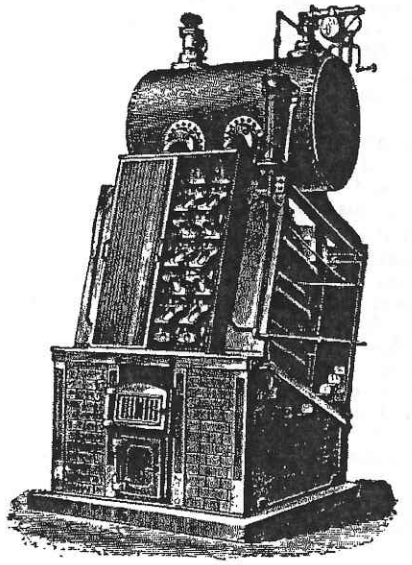

FIG. 117.

CODE WORD	... ...	Ash	Bud	Cocoa	Drug	Elms	Fir
	NOMINAL HORSE-POWER	15	20	25	30	40	50
	Heating surface, sq. ft.	173	230	288	345	460	575
Ape	Price—Fig. 117, iron-work only	£165	£205	£240	£270	£320	£365
Bat	Do., do., with iron casing & W.I. chimney	£65	£76	£88	£100	£112	£132
Chick	Extra price, for fire-bricks, quarries, and clay for lining ...	£14	£15	£16	£18	£21	£24
Dove	Price, pump and connections	£20	£20	£25	£25	£30	£35
	Space occupied, inches	114×56	114×64	114×72	114×80	114×88	114×96
	Approx. weight, Fig. 117, ironwork only	5½ tons	6½ tons	7 tons	8 tons	10 tons	12½ tons

EXTRAS.—If no piece is to exceed 10 cwt. 5 per cent.
,, ,, 5 ,, 7½ ,,
,, ,, 3 ,, 10 ,,
,, ,, 1½ ,, 15 ,,

VERTICAL CROSS-TUBE BOILER

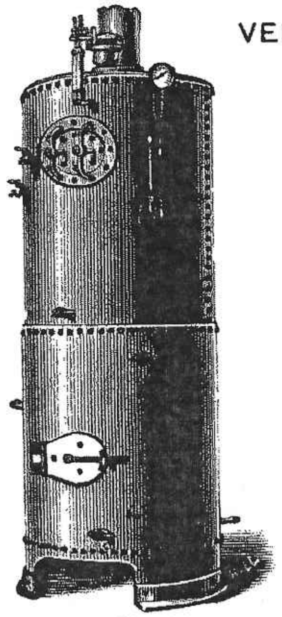

FIG. 38.

These boilers are of the form known as "Vertical cross-tube boilers," or to English contractors' men as "Coffee-pots." They are a useful type for small powers where first cost must be considered, and where they are subjected to a maximum amount of rough work with a minimum of care or cleaning.

They are constructed of mild steel plates throughout, or of best Staffordshire shell, and treble best fire-boxes, crown-plates, and uptakes, Lowmoor cross-tubes, or equal quality.

All these boilers over 3 ft. in diameter are double rivetted in their vertical seams, they are all tested to 120 lbs. per square inch, and the fittings to each boiler consist of the following:— Man and mud holes with doors and fastenings, furnace-door, grate-bars and bearing-ring, 4 ft. of chimney, blow-off cock, safety-valve with Salter's spring balance, steam-gauge, water-gauge, gun-metal gauge-cocks, 4 in. diameter steam-gauge, fusible safety-plug in crown of the fire-box.

CODE WORD	... ...	Ash	Bud	Cocoa	Drug	Elms	Fir
	NOMINAL HORSE-POWER ...	2	4	6	8	10	12
	Height ... ... feet	5	6	7	7½	8	9
	Diameter ... ... "	2¼	2¾	3	3½	4	4¼
	No. of cross-tubes	1	1	2	2	3	3
Ape	Price of boiler	£21	£30	£38	£45	£60	£78
Bat	" " " complete ...	£26	£38	£45	£52	£70	£90
	Approximate weight ...cwt.	12	16½	22	26	39	47
Chick	Price for cleating	£6	£8	£10	£12	£15	£20

Double safety-valves, £1 10*s*. to £4 extra.

Suitable size of injectors, including cock-pipes, and fitting same to the boilers, £5 to £10. Donkey pump, including connection and fitting to boilers, £10 to £20.

The cleating consists of a thick coating next the boiler, covered by wood lagging, and a neat outer casing of sheet steel, with hoops, the crown covered in the same manner, the outer plate flanged from ⅛-in. steel plate, and all the man and mud holes and fire-hole fitted with neat rings around them. For shipment this casing is protected by rough timber lagging and hoop iron.

CORNES' PATENT VERTICAL BOILER.

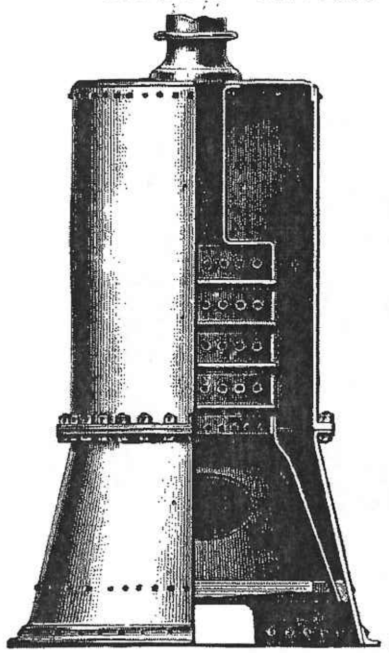

FIG. 39.

The special features claimed for these boilers, shown in half section by Figure 39, are that they will evaporate as much water per lb. of fuel as any form of boiler in use, while they occupy a limited ground area. Can be taken apart, for cleaning or repair, and reinstated after cleaning by the ordinary stoker in a few minutes; or for transport, they are easily made sectional. By means of the conical form of the bottom portion a very large grate area is obtained for wood-burning or for inferior coal. This class of boiler, under test at the Royal Agricultural Society's Meeting, at Bedford, 1874, was found to evaporate 10·09 lbs. of water per lb. of coal, a performance barely equalled by the best locomotive boiler under trial at the same meeting. (*See* Society's report.)

The boiler shells are made vertical, unless required for wood-burning or inferior coal, the prices of each being given below. For yachts or fire-engine purposes the proportions are considerably altered, the heigh being less and the diameter greater.

They are constructed throughout of mild steel, of welding and flanging quality, of about 28 tons tensile strain, 20 to 25 per cwt. elongation, angle iron rings faced, drilled holes and turned bolts, to stand 100 lbs. working pressure, hydraulic test, 200 lbs.

CODE WORD	... ...	Ash	Bud	Cocoa	Drug	Elms	Fir
	NOMINAL HORSE-POWER ...	6	8	10	15	20	25
	Height ... ... feet	7	7	7½	8	9	10
	Diameter ... ... "	2¾	3	3¼	3½	4	4½
Ape	Price, with vertical shell ...	£75	£90	£100	£130	£150	£175
Bat	" " conical " ...	£80	£100	£115	£150	£175	£200
Chick	" of fittings	£8	£10	£12	£15	£20	£25
Dove	" " cleating	£10	£12	£15	£20	£22	£25
	Approx. total weight ...cwt.	20	24	30	40	60	80

Prices of injectors and donkey pump same as given for cross-tube boiler, Figure 38, and the list of fittings are the same, but include spring scraper for boiler-tubes, and box spanners for the bolted joints; these joints are made with wire woven asbestos insertion, and can easily be made absolutely tight.

SEMI-PORTABLE LOCOMOTIVE BOILER.

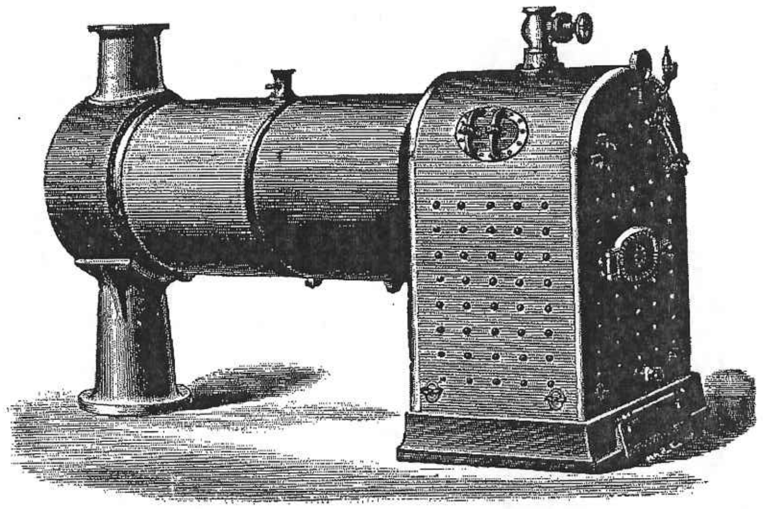

Fig. 26.

The advantages of locomotive boilers are that they are very economical, require neither brick setting or brick chimney-shaft, are very portable and light for transport or shipment in proportion to the power they develop, and, by making the fire-boxes extra large, wood or low-class fuel can be used.

The boilers are made of best mild steel, equal to 27 to 28 tons tensile strain, with at least 25 per cent. elongation. Fire-boxes of this quality have a longer life than when made from any other brand, not excepting Lowmoor.

The workmanship throughout is of the very highest, and they are constructed for a safe working pressure of 100 lbs., and a test of 200 lbs. The fittings are most complete, and, in addition to those shown, include 12 ft. of chimney.

CODE WORD	... ...	Ash	Bud	Cocoa	Drug	Elms	Fir	Grape	Hazel	Ilex
	Nom. Horse-power	4	6	8	10	15	20	30	40	50
Ape	Price, complete ...	£65	£80	£92	£106	£132	£173	£230	£277	£325
Bat	,, large wood-burning fire-box	£4	£6	£8	£10	£15	£20	£30	£40	£50
Chick	Price for wheels and axles ...	£10	£12	£14	£16	£20	£25	£30	£35	£40
Dove	Price for donkey or injector ...	£10	£15	£15	£15	£20	£20	£20	£25	£25
	Approx. weight, cwt	25	30	35	40	48	54	60	80	100

FIELDING'S PATENT DUPLEX PUMPING ENGINE.

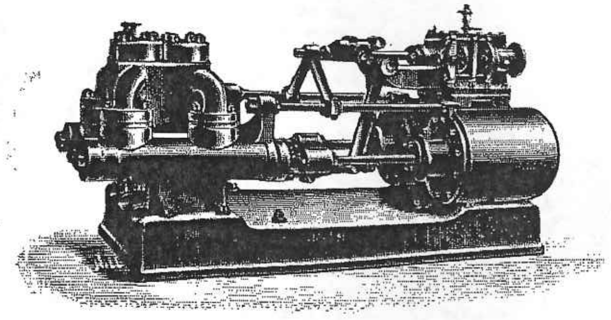

Fig. 53.

The duplex is the only non-rotative pumping engine which has positive valve gear, and to this important feature are due their reliability, silence and smoothness of working, great efficiency and durability.

Duplex pumping engines have hitherto consisted of two entirely distinct and complete engines, placed side by side, the slide-valve of each being operated by the cross-head of the other.

The distinctive feature of the Fielding duplex engine is that, instead of each cylinder being fitted with its own slide-valve, a single valve serves both cylinders, thus causing an important reduction in the number of parts subject to wear, and requiring attention.

Notwithstanding this reduction in the number of working parts, the whole of the requirements are not only perfectly fulfilled, but in such a manner as to greatly improve the wearing qualities of the valve surfaces, and also to ensure their permanent steam tightness.

There is no dead point in duplex pumping engines, and they will consequently start from any position on steam being turned on, even after having been for long periods inactive.

The important advantages of this type of pumping engine are by no means confined to the cylinders and valve-gear, but apply equally to the pumps, conducing greatly to improved working.

One of the consequences of the steam distribution to each engine being due to the movement of the cross-head of the other, is that each pump-plunger commences its stroke as the other comes to rest.

Thus the flow of water in the suction and delivery-pipes is steadily maintained with little or no pulsation, whilst a pause is made by each plunger at the end of its stroke, enabling the chamber to become completely charged, the valves quietly seating by their own weight alone.

Duplex pumps are remarkable for their **silence, regularity of delivery, and great efficiency,** whilst their wear and tear is insignificant.

FIELDING'S PATENT DUPLEX PUMPS.

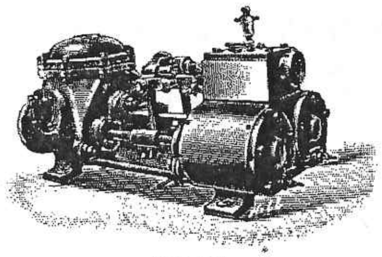

FIG. 54.

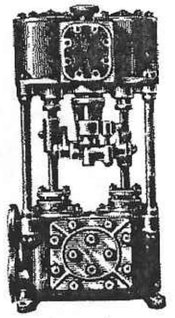

FIG. 55.

PRICES OF HORIZONTAL OR VERTICAL PUMPS.

CODE WORD	... ...	Ash	Bud	Cocoa	Drug	Elms	Fir
	Gallons per hour	460	630	820	1,300	1,850	3,300
	Dimensions ... inches	3 × 1½ × 3	3 × 1¾ × 3	3 × 2 × 3	3½ × 2½ × 4	3½ × 3 × 4	6 × 4 × 5
Ape	Price of horizontal ...	£15	£17	£19	£20	£21	£38
Bat	" if brass-lined ...	£16	£19	£21	£22	£23	£42
Chick	" of vertical	£15	£18	£20	£23	£24	£45
Dove	" if brass-lined ...	£24	£26	£28	£35	£38	£60
CODE WORD	... ...	Grape	Hazel	Ilex	Jam	Kernel	Lichen
	Gallons per hour	3,300	5,100	5,100	9,300	9.300	11,000
	Dimensions ... inches	7 × 4 × 5	6 × 5 × 5	7 × 5 × 5	8 × 5½ × 6	9 × 5½ × 6	9 × 6 × 6
Ewes	Price of horizontal ...	£50	£45	£55	£70	£90	£100
Fox	" if brass-lined ...	£55	£50	£60	£80	£100	£110
Goats	" of vertical	£55	£50	£60	£85	£105	£110
Heron	" if brass-lined ...	£70	£62	£75	£105	£125	£130

The dimensions referred to in the above tables are read as follows :—(3 in. × 1½ in. × 3 in.)—3-in. diameter of steam cylinder, 1½ in. diameter of pumps, both, of course, of 3-in. stroke. All pumps are quadruple.

When comparing these pumps with others it must be remembered that these pumps have double steam cylinders and double pumps, therefore, their capacity will be double that of any single pump of equal dimensions.

The pump bodies are of cast iron, with gun-metal liners, piston rods, valves, seats, and glands, all the nuts, studs, and bolts are machined, and the cylinders covered with planished steel. The capacities are based on a very low piston speed, and the valve areas are all very large.

These pumps are particularly well adapted for shaft-sinking or mine drainage. For the former purpose they are made with quadruple rams, all having outside packings, so that the packing can be readily renewed, and kept in order. These pumps will work equally well when slung in chains, and for this service, the vertical pattern, Figure 55, with suitable chain attachments, is recommended; for drainage purposes, either the vertical pattern, Figure 55, or horizontal patterns, Figures 53 and 54, are suitable.

These duplex pumps can also be fitted with hydraulic motor cylinders, instead of steam, and will, in deep workings, be found the most convenient and economical means of transmitting power to underground pumps. When this system is adopted, a duplex pump is required on the surface, equal in power and capacity, to work any given number of underground pumps, and from which mains and branches may be let to any depth or distance away, without any appreciable loss, the exhaust water from the motor cylinders going into the rising main of the pumps. Figure 56 shows one of these pumps on wheels, used for sinking a deep shaft at an angle of 40°, and, after the full depth was reached, the same pump was taken off its wheels, and fixed permanently in a heading. Several of these pumps were driven, by one surface pumping engine, in separate shafts, nearly a mile apart, the control being perfect without any attention on the part of the driver of the surface-pump. The steam was always left full on, and if the miners stopped one of the sinking-pumps, the surface-pump would work at one-half its normal speed; if both were stopped together, the surface-pump would stop, or simply crawl to supply leakage; but on one pump being put to work again in the mine, the pump, having no dead centre or stopping point, would move off at the required speed to supply the one pump, and when both mine pumps were put on together, the surface-pump would go on at an increased speed, sufficient to supply both mine-pumps. The advantage of avoiding hot steam-pipes, or exhaust steam-pipes, in shafts, galleries or headings, with their attendant loss of efficiency from condensation, will be fully appreciated by mining men. From want of space, and to prevent repetition, we are compelled to limit our list of these pumps in this section, as they are given fully in our section on "Pumping Machinery," but they are made simple or compound, with or without condensers, of the suction, surface, or jet kind, and of any capacity, or to work under any pressure, 3,000 ft., or more, being easily raised at one lift.

In applications for estimates for mine-pumps, the following data should accompany it :—

The approximate quantity of water per minute.
The total height of lift.
The pressure of steam available.
If to be worked by steam or hydraulic cylinders.
The kind of service the pump is intended for.
Sinking or permanent service.
If for a vertical shaft or incline—if the latter, give the angle of incline.

FIELDING'S PATENT DUPLEX, WITH HYDRAULIC MOTOR.

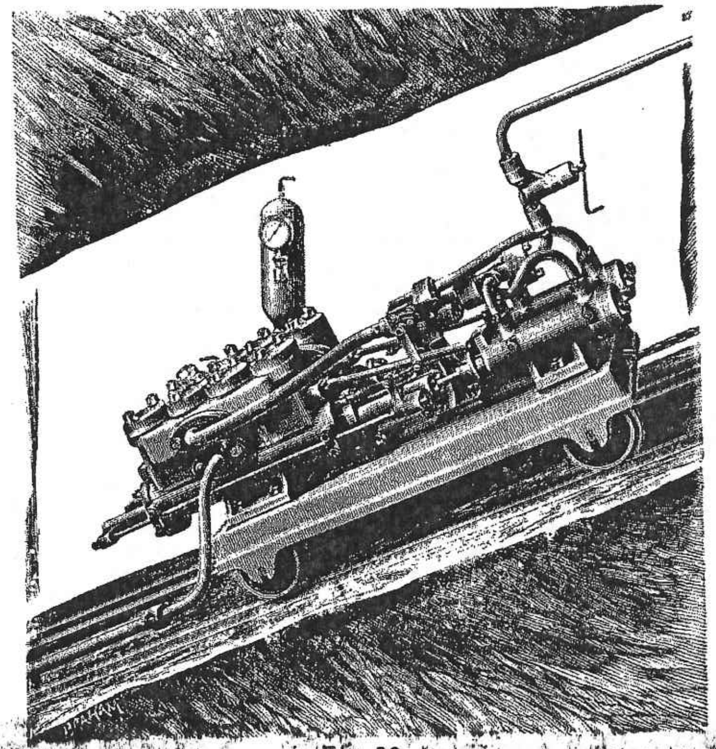

Fig. 56.

The above engraving is from a photograph of one of the two pumps referred to in our description on the next page, and these were supplied to the Lixa Mining Co. for their mines in Portugal. These pumps had quadruple rams of 3½ in. diameter × 6 in. stroke, the hydraulic cylinders being 3 in. diameter. The working pressure was 1,500 lbs. per square inch, and this was given by the surface pumping engine, which had two steam cylinders of 12 in. diameter × 12 in. stroke, with steam at 100 lbs. initial pressure, the surface-pump easily supplying these two pumps. The underground pumps were each equal to pumping 60 gallons per minute, from an inclined shaft 400 metres deep, and this work they did with great ease, and with less expense and loss than could have been accomplished by any other means. The prices of these pumps were £100 each (Ape), the hydraulic cylinders and their valves, &c., being of gun-metal throughout.

CORNISH PUMPS.

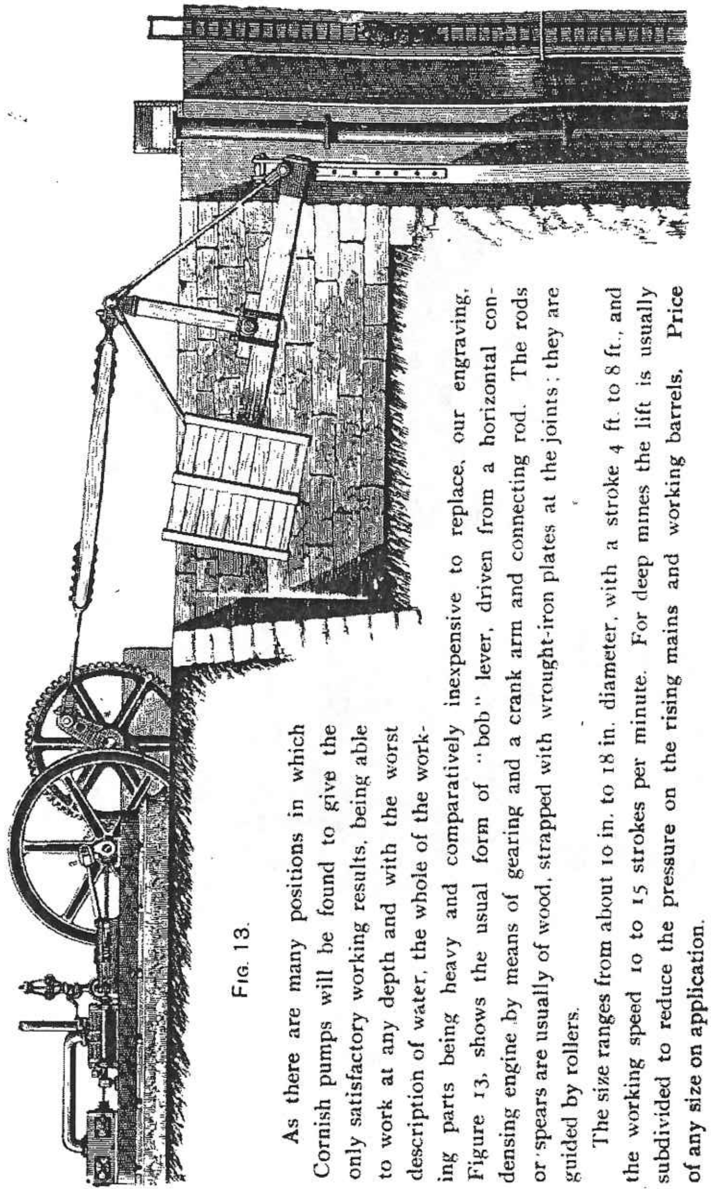

Fig. 13.

As there are many positions in which Cornish pumps will be found to give the only satisfactory working results, being able to work at any depth and with the worst description of water, the whole of the working parts being heavy and comparatively inexpensive to replace, our engraving, Figure 13, shows the usual form of "bob" lever, driven from a horizontal condensing engine by means of gearing and a crank arm and connecting rod. The rods or spears are usually of wood, strapped with wrought-iron plates at the joints; they are guided by rollers.

The size ranges from about 10 in. to 18 in. diameter, with a stroke 4 ft. to 8 ft., and the working speed 10 to 15 strokes per minute. For deep mines the lift is usually subdivided to reduce the pressure on the rising mains and working barrels. Price of any size on application.

DIAMOND PROSPECTING OR BORING MACHINES.

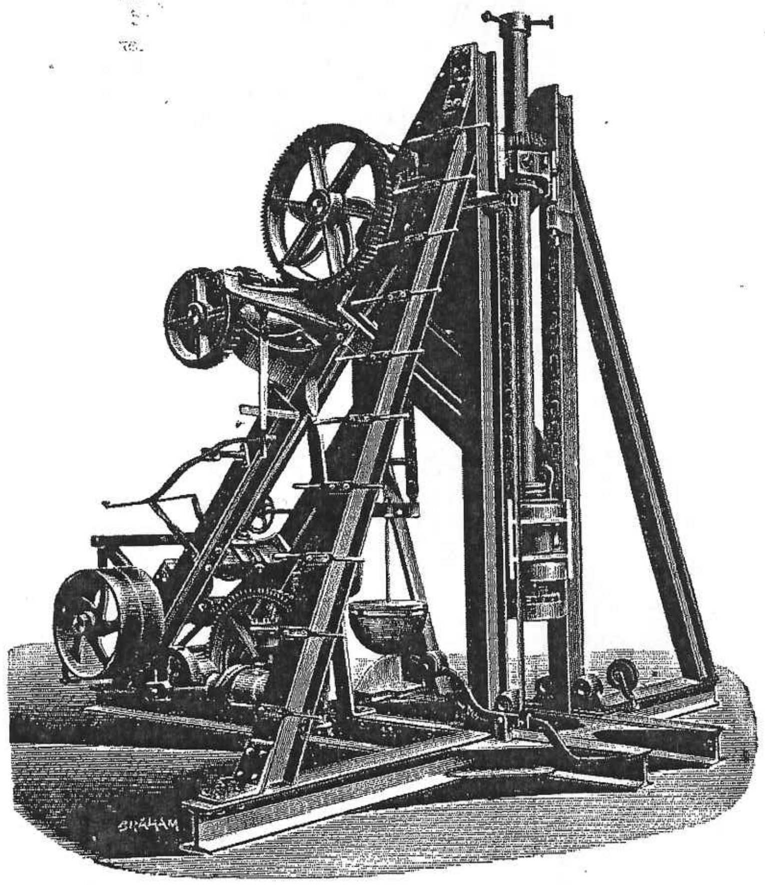

FIG. 40.

Since the early days of deep boring, either for the purpose of testing ground for minerals or for forming artesian wells, mechanical science in this direction has kept pace with that of other industries.

In 1834, when a bore-hole was commenced at Grenelle, near Paris, for water-supply, before the water was reached at 1,800 ft. below the surface the works had been in operation some seven years, the hole having been completed only in 1841; now, with a machine such as that shown at Figure 40, the same work would be done in almost as many weeks, and, of course, at a fraction of the cost. As an instance of this, we have on record a case in which a contract near Hamm, in Westphalia, had reached a depth of 1,460 ft. with one of these machines, and the mineral wanted was not then being found. A fresh contract was entered into, and boring from that depth was proceeded with, and 548 ft. was put down in nineteen days—a performance, we believe, considering the depth, never yet surpassed. Again, at Port Clarence, in Middlesboro', a bore-hole of 19-in. diameter at the top reduced to 16-in. diameter at about 1,150 ft. deep, and completely lined with tubes, was put down in about fifty-two weeks—all ready for pumping.

The machine illustrated is the result of much practical experience, both from a mechanical and engineering point of view, since the crude invention was patented in France and England by M. Leschot, and the English rights afterwards purchased by Appleby and Beaumont in 1867, and which really only consisted of setting carbonates or black diamonds in a circle, so that by abrasion they would cut an annular groove or chase, and leave a core in the centre, the tubular rod or boring-tube admitting of this core passing up its centre, and water under pressure being forced down the tube serving to lubricate the action of the carbonates, and passing up around the outside of the boring-rod keeping it free from debris, and free to revolve.

Starting from this mere idea, the designs for the present machine were built up in Messrs. Appleby Bros. works while the writer was engineer and manager there. For prospecting work for great depths it was found that although at starting large-diameter holes, the weight of the short length of boring-rod and its driving quill was insufficient to cause the necessary abrasion or cutting in hard ground, as the hole became deeper, and consequently the weight of rods greater, this weight had to be relieved, or the carbonates would fracture and be lost in the hole, and the "crown," as it is termed, be rendered useless. This difficulty was overcome by the use of the chains shown attached to the cross-head, on which loose weights could be put on either side to increase the weight or relieve it, and as each length of rod was added of a known weight, the weights on the chain were changed, the driving quill had a vertical stroke of about 6 ft. on the uprights of the machine, and when the hole was put down this depth the universal clutch is slacked off, and the driving quill with its cross-head raised by suitable gearing to the top of its travel, and another length of rod screwed on, the clutch again affixed to the rod, and the boring proceeded with. On the machine a separate and powerful lifting gear is also provided for lifting the boring-rods, by means of a chain and block-sling from a set of steer legs as high as possible over the centre of the machine by guy ropes, enabling three or four lengths of rod to be lifted or replaced at one lift, saving much time in unscrewing and recoupling the rods. For very deep borings, and those of large diameter, it is usual to erect rather a formidable timber framing over the bore-hole of sufficient space to contain the machine, and a lean-to from it to contain the portable engine; this frame is some 50 ft. to 60 ft. high, and of sufficient strength to safely carry a load of 10 tons—a considerable weight of rods and core having sometimes to be lifted. We have seen a piece of core of 16 in. diameter, some 30 ft. long, without a fault in it, weighing upwards of 3 tons, that was bored out and lifted by one of the machines of the pattern illustrated. In addition to the gearing for driving the boring-rods, lifting the counterweights, and lifting the rods or tubes, a power-pump, with a variable stroke, is fitted with air-vessel and relief-valve to pump the water through the hollow boring-rods down to the boring "crown," and, as before explained, to keep the outside free from debris, and as the supply of water is of vital importance it is usual to have the pumps in duplicate. The water is taken from the pump by means of a strong flexible hose to a water swivel union on the top length of the boring-rod that admits of the rods rotating, the union being prevented from doing so by a guard-iron (not shown in the engraving), this flexible hose, of course, allows of the rods descending.

The price of this machine as shown is £380 (Ape); or, if fitted with double pumps, £395 (Bat).

We annex what may be considered a complete outfit for such a machine, ready for work, for 2,000 ft. deep.

Boring machine as above.
Portable engine of 10 H.P.
2 straps for same.
6 1¼-in. flexible hoses.
3 pair of unions.
2 water-unions.
150 ft. of ⅜-in. chain.
1 18-in. top sheave with spindle and bearings.
2,000 ft. of steel boring-rods and joints.
300 ft. of 6-in. steel lining-tubes with steel joints.
400 ft. of 5-in. ditto with ditto.
600 ,, 4 ,, ,,
800 ,, 3 ,, ,,
Special connectors—6-in. to 5-in., 5-in. to 4-in., 4-in. to 3-in.
6-in. to 3-in. steel driving-shoes.
2 15-ft. core tubes.
2 special connectors of boring-rod to core-tubes.
2 special connectors of rods to 3-in. tubes.

2 6-in. boring-crowns
2 5 ,, ,,
2 4 ,, ,,
2 3 ,, ,,
4 2 ,, ,,
unset.
4 core-clips.
2 6-ton hydraulic jacks.
1 3-ton set of blocks and falls.
2 lifting-swivels for rods.
1 set of eccentric-clips.
4 patent rod-tongs.
2 ,, tongs for 3-in. tubes.
2 ,, ,, 4 ,, ,,
2 ,, ,, 5 ,, ,,
2 ,, ,, 6 ,, ,,
1 complete set of diamond setting tools in lock-up box.
1 5-in. parallel vice.
1 complete set of spanners.
2 patent shifting wrenches.
1 1-gall. oil-can and 2 oil-feeders.
1 set of stoking tools.
1 set of spare valves for the pumps.
1 spare set of pinions in steel.
About 200 carats of carbonates or black diamonds.

This complete machine, engine, and outfit, will cost about £1,400 (Chick) exclusive of the carbonates, which vary considerably in value, and can only be quoted for from week to week; the present price is about 42/- per carat.

For putting down small holes for prospecting a depth, say up to 500 ft. deep, we supply a very portable and handy plant, self-contained, with the engine and boiler, and mounted on a set of four wrought-iron wheels, with locking fore-carriage, shafts or pole, that can be as readily transported as the ordinary portable engine. The cost of such a machine with 6 H.P., and high-pressure boiler of the fire-engine type (Figure 39), and an outfit for holes up to the depth above stated, would be £700 (Ape).

But where deep holes are required, the machine, Figure 40, is recommended, and although the total weight packed is some 12 tons, yet the machine is constructed that no single part exceeds 10 cwt., so that in some districts, although the total weight is much greater than the portable one, it can be more easily transported.

This invention was soon pirated by other countries, in which the law of patent right is very loose, or where it does not exist, using single or double hydraulic cylinders, to apply the pressure to the diamond tool, but such contrivances are very defective and uncertain, the pressure that may be applied depending too much on the attention of the operator, and the pressure could be instantly raised so as to completely shatter the carbonates, twist off the rods and lose a hole — a dead weight steadily applied to the rods, to assist or relieve them, being far simpler and certain in action.

It must not be assumed that either of these machines can be operated by anyone; such is not the case. They require to be in the hands of careful men accustomed to this class of work, guided by a chief of superior intelligence and mechanical resource. We have known them do wonders in the way of boring when so directed, and the same machines, in the hands of unskilful men, have been sent out and never succeeded in putting down a single hole properly—only losing their diamond tools, rods, and tubes.

We, therefore, recommend them to be worked by a small syndicate or company, with a first-class set of hands and director, that may take the contracts from mining property owners, rather than the owners themselves buying the machines and attempting to work them without the necessary skilled hands.

For prices of lining-tubes, *see* page 82.

These machines can be often made available for boring ventilating holes in the ends of drifts, answering the purpose at much less cost than shaft sinking, or they have been used with great advantage in putting down anchorages for suspension bridge chains, moorings, &c., sinking petroleum wells, boring out rock for the foundations of iron piles or columns under water for the erection of jetties or piers, lighthouses and beacons, or for any subaqueous work from a barge of special construction, furnished with appliances for keeping it perfectly steady while boring.

BORING TOOLS,

For Testing Ground, Boring Wells, &c.

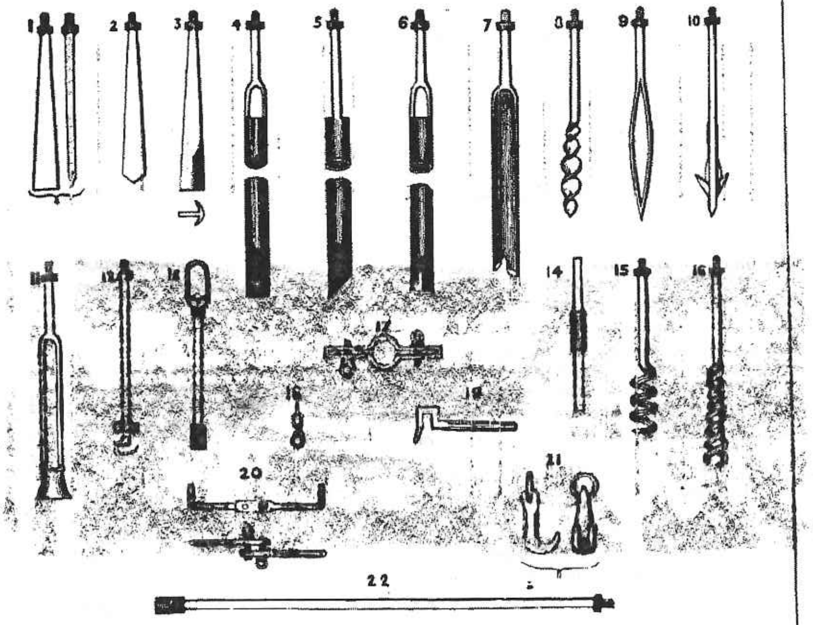

FIG. 20.

No. 1. Flat chisels for flinty and hard strata.
,, 2. V ditto.
,, 3. T ,,
,, 4. Shell for loose and sandy soil.
,, 5. Ditto, with shoe nose.
,, 6. ,, ,, auger nose.
,, 7. Auger for clay.
,, 8. Worm auger for loosening close soils.
,, 9. Springs for enlarging bore hole.
,, 10. Spring dart for drawing pipes from bore hole.
,, 11. Bell box for extracting broken rods.
No. 12. Crow's foot for extracting broken rods.
,, 13. Swivel top rod.
,, 14. Well rod joint.
,, 15. Spiral worm for extracting broken rods., &c.
,, 16. Spiral worm, double.
,, 17. Pipe clambs.
,, 18. Spring hook.
,, 19. Hand dog for screwing up and unscrewing rods.
,, 20. Tillers for working the rods.
,, 21. Lifting dog for raising rods.
,, 22. Well boring rod.

Estimates and Prices of Pipe upon application.

BORING TOOLS—*continued.*

The subjoined specifications, and prices attached thereto, are based on the actual cost of sets of boring tools, manufactured and supplied, and from this data a close approximation of the cost of a set of tools for any depth up to 1,000 feet can be obtained:—

A set of boring tools, for 50 ft. deep, consists of nine 6 ft. lengths of 1 in. square boring rods; one each 2½ in., 3 in., and 4 in. augers; one each 2½ in., 3 in., and 4 in. chisels; one each 2 in., and 3 in. shells with auger nose; one 2 in. flat nose shell auger; one auger clearer; one auger board; 2 hand dogs; two lifting dogs; one pair of tillers; one rigger and carriage; one spring hook; 30 ft. rope; and one short swivel rod. Price £30 (Ape). Additional, 1 in. boring rods, 6 ft. long, £1 each (Bat).

A set of boring tools, for 100 ft. deep, consists of ten 10 ft. lengths of 1 in. square boring rods; one each 3 in., 4 in., 5 in., and 6 in. augers; one each 2½ in., 3 in., 4 in, 5 in., and 6 in. chisels; one each 3 in., 4 in., and 6 in. shells, with auger nose; one 2½ in. flat nose shell auger; one auger clearer; one auger board; two hand dogs; two lifting dogs; one pair of tillers; one rigger and carriage; one spring hook; 30 ft. rope; and one short swivel rod. Price £45 (Chick). Additional, 1 in. boring rods, 10 ft. long, £1 5*s.* each (Dove).

A set of boring tools, for 150 ft., 200 ft., and 300 ft. deep, will comprise the same tools as the set for 100 ft. deep, plus the additional lengths of boring rods, the price of which is given above.

A set of boring tools, for 500 ft. deep, consists of fifty 10 ft. lengths of 1½ in. square boring rods; one each 4¼ in., 5¼ in., 6¼ in, 7¼ in., and 8¼ in. augers; one each 4¼ in, 5¼ in., 6¼ in., 7¼ in., and 8¼ in. flat chisels; one each 4¼ in., 5¼ in., 6¼ in., 7¼ in., and 8¼ in. T chisels; one each 4¼ in., 5¼ in., 6¼ in., 7¼ in., and 8¼ in. cross chisels; one each 4¼ in. 5¼ in., 6¼ in., 7¼ in., and 8¼ in. S chisels; one each 3¼ in., 4¼ in., 5¼ in., 6¼ in., and 7¼ in. shells, with auger nose; one each 3¼ in., 4¼ in., 5¼ in, 6¼ in., and 7¼ in. flat nose shell augers; one auger clearer; one auger board; four hand dogs; two lifting dogs; two pan tillers; one rigger and carriage; one spring hook; 30 ft. rope; one short swivel rod; two worm augers; one worm; two bell boxes; one bell screw; one crow's foot; two rests; one snatch block; two spring darts; six pairs of spare well rod joints; six spare tiller screws; six sets of pipe clams. Price £235 (Ewes). Additional, 1½ in. boring rods, 10 ft. long, £1 15*s.* each (Fox)

Set of boring tools, above 500 ft. deep, will consist of the same tools as the set for 500 ft. deep, plus the additional lengths of boring rods required, the price of which will be found above, viz.—£1 15*s.* per 10 ft. length (Goats)

The prices of chisels, augers, misers, &c., for large bore-holes, vary according to sizes and designs.

A set of ironwork for shear legs .. .. Price £3 to £5 (Heron).
A well sinker's windlass, for sets up to 200 ft. deep ,, £13 10*s.* (Ibis).
Ditto 500 ,, ,, ,, £30 (Jay)
Ditto 1000 ,, ,, arranged to work by steam or hand power. } ,, £45 (Kraken)

PATENT SAFETY FUSES.

Prices are given below for coils of 24 ft. each.

CODE WORD	No.		Per coil of 24 ft
Use Numbers opposite each Article.	1	Small fuse, for dry ground	3d., 3½d.
	2	Superior ,, ,, ...	0 4
	3	White fuse, for dry and close places and warm climates	0 3½
	4	Red ,, ,, ,, ,, ,,	0 4
	5	Yellow ,, ,, ,, ,, ,,	0 4
	6	White ,, (black varnish on inside), for damp ground and hot climates	0 4
	7	Sized fuse, for damp ground and warm climates	0 4
	8	Double-laid fuse, for rough ground and damp places ...	0 4
	9	Yellow double-laid fuse, for rough ground, damp places, and warm climates	0 4½
	10	Red ditto, for ditto	0 4½
	11	White ditto, for ditto	0 4½
	12	White ditto (black varnish on inside), for damp ground and hot climates	0 4½
	13	Sized double-laid fuse, for damp ground and warm climates	0 4½
	14	Thread sump fuse, for wet ground	0 5
	15	Yellow thread sump fuse, for wet ground and hot climates	0 5½
	16	White ,, ,, ,, ,, ,,	0 5½
	17	Red ,, ,, ,, ,, ,,	0 5½
	17a	Treble-wove fuse, for wet ground	0 6
	18	Treble-countered fuse, for very wet ground	0 7
	19	Red treble-countered fuse, for very wet ground and hot climates	0 7½
	20	White ditto, for ditto	0 7½
	21	Yellow ditto, for ditto	0 7½
	21a	Quarry and deep hole fuse, for igniting at bottom of charge	0 10
	22	Small tape fuse, for wet ground	0 5
	23	Tape sump fuse ,, ...	0 5½
	24	Superior tape fuse, for very wet ground	0 6
	25	Yellow tape fuse, for wet and close places, and hot climates	0 6½
	26	Red ditto, for ditto	0 6½
	27	White ditto, for ditto	0 6
	28	Small double tape fuse (to fit dynamite detonator), for very wet ground	0 8
	29	Double tape fuse, for very wet ground	0 8
	30	Superior double tape fuse, for very wet ground	0 8½
	31	Red double tape fuse, for very wet ground and hot climates	0 8½
	32	Yellow ditto, for ditto	0 8½
	33	White ditto, for ditto	0 8½
	34	Tape-countered fuse, for rough treatment and wet ground	0 7½
	34a	White thread countered gutta-percha fuse, for wet ground	0 8
	34b	White tape gutta-percha fuse, for very wet ground ...	0 8½
	35	Small gutta-percha fuse, for wet ground	0 9
	36	Best ,, ,, very wet ground or in water	0 10

PATENT SAFETY FUSES—*continued.*

CODE WORD	No.			Per coil of 24 ft.
				s. d.
Use Numbers opposite each Article.	37	Best tape gutta-percha fuse, for deep water up to 60 feet		1 0
	38	,, white tape gutta percha fuse, for deep water and hot climates		1 1
	39	Double gutta-percha fuse, for deep water		1 6
	40	Treble ,, ,, very deep water		2 6
	41	Double-laid patent gutta-percha ribbon fuse	These fuses are suitable for any climate, hot or cold, and are not subject to deterioration from the atmosphere, same as ordinary gutta-percha.	0 6
	42	Brown ditto		0 6½
	43	Thread sump patent gutta-percha ribbon fuse		0 7
	44	Brown ditto		0 7½
	45	Tape patent gutta-percha ribbon fuse		0 8
	46	Brown ditto		0 8½

The fuses are made for all climates, and of any length, or of any special description, and of sufficient water-resisting properties to ensure ignition at any depth. Advice is readily given as to the description best suited for any particular climate or requirement.

WROUGHT-IRON BORE PIPES with Screwed Flush Joints, inside and outside, in 10-feet lengths.

CODE WORD	... ...	Ash	Bud	Cocoa	Drug	Elms	Fir	Grape
	OUTSIDE DIAMETER	2 in.	3 in.	4 in.	5 in.	6 in.	8 in.	9 in.
	Thickness B.W.G.	11	11	9	8	7	4	4
Ape	Price per foot	2/-	3/-	4/-	5/6	7/6	14/-	19/-

WROUGHT-IRON BRAZED PIPE with Collars, and WROUGHT-IRON RIVETTED BORE PIPES.

CODE WORD	... ...	Hazel	Ilex	Jam	Kernel	Lichen	Mahogany	Nuttrees
	OUTSIDE DIAMETER	3 in.	4 in.	5 in.	6 in.	8 in.	10 in.	12 in.
	Thickness B.W.G...	15	14	14	12	12	10	10
Bat	Price of brazed pipe, with collars, per foot	3/6	4/6	5/6	7/-	9/6	13/6	17/-
Chick	Ditto, rivetted ...	3/-	3/6	4/6	5/6	7/-	9/-	13/-
Dove	Ditto, steel collars and shoes, each set	11/6	13/6	16/6	22/6	45/-	80/-	105/-

Packing for shipment, about 3 per cent. extra.

Bore pipes in cast iron, with turned ends, and fitted with wrought-iron collars and countersunk screws are sometimes preferred, but they are heavy and expensive in comparison with wrought-iron pipes.

Cast-iron cylinders for lining wells, with faced flanges, £6 to £8 per ton, according to size.

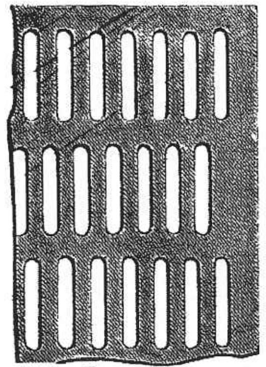

FIG. 43.

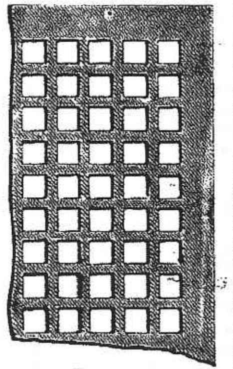

FIG. 44.

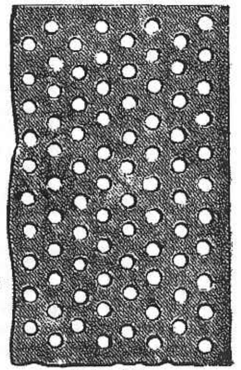

FIG. 45.

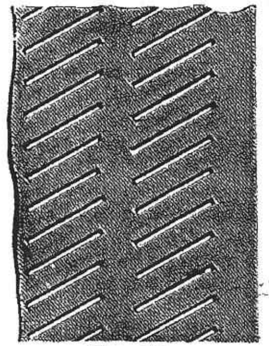

FIG. 46.

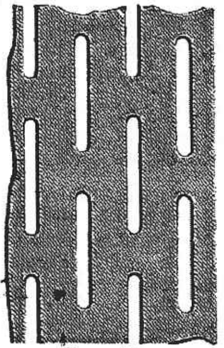

FIG. 47.

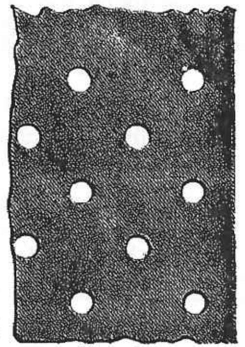

FIG. 48.

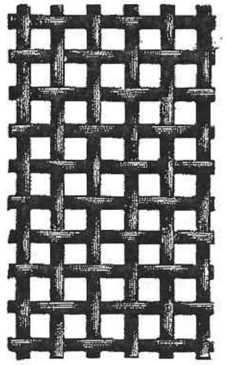

FIG. 49.

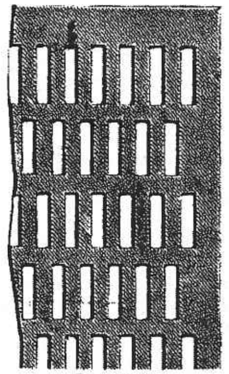

FIG. 50.

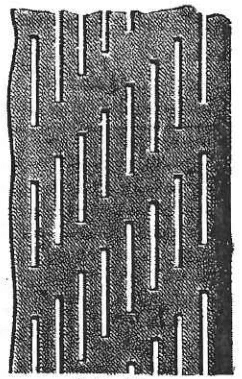

FIG. 51.

PERFORATED METAL AND WOVEN WIRE.

On page 83, we give engravings of eight different kinds of perforated metals, Figures 43 to 51, and one specimen of woven wire cloth, Figure 49.

Figure 43 is used for screens of various kinds, and can be made in steel, iron, brass, or zinc, with perforations $^{1}/_{16}$ in. × $^{15}/_{32}$ in. or $^{1}/_{14}$ × $^{15}/_{16}$ in.

Figure 44 is for various screens for mining purposes, and can be supplied in steel, iron, brass, or zinc, the perforations of 1½, 2, 2½, 3, 3½, 4, and 5 millimetres.

Figure 45 can be supplied with round holes, punched from 1 mill. diam. to 25 mill. diam., in steel, iron, brass, or zinc, the thickness in proportion to the diameter of hole.

Figure 46 is diagonal needle slot punched metal, and chiefly for screens in stamp batteries and on Huntington mills. Can be made in steel, iron, brass, or zinc, perforated with half-length of slots, No. 1 to 12 needle, the perforations being either punched clean or left with burr.

Figure 47 shows slot perforations with round ends, or, as they are sometimes called, oval perforations. This is frequently used for screens for various mining purposes or drying floors. Can be supplied with perforations 1.75 mill. × 14 mill., 1.75 mill. × 25 mill., 4 mill. × 32 mill., and 10 mill. × 25 mill., and may be had in any kind of metal.

Figure 48 is perforated in iron or steel, and is used chiefly for grizzley screens, the perforations being much wider apart than Figure 45, to give greater strength. Can be punched 3 to 10 mill. diam.

Figure 50 can be had in any metal, and is used for mining screens, and also for flax screens, and is made in about three sizes.

Figure 51 is sometimes preferred to Figure 46, and can be supplied in the same metals and middle sizes, 1 to 12, either clean or burr.

Table showing the thickness of iron or steel that can be punched with a given diameter of hole.

Diameter of hole ... mill.	0.75	1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	5.5	6.0	8	10
Thickness of steel, B.W.G.	28	26	24	20	18	16	15	14	12	11	10	6	5
„ „ iron, B.W.G.	26	24	22	18	16	14	13	12	10	9	8	4	3
Weight per super. foot, lbs.	0.8	1.0	1.5	1.8	2.5	3.1	3.7	4.3	5.6	6.2	6.8	9.3	10

Russian iron plates are supplied 28 in. × 56 in.

Figure 49 is by some preferred for battery screens, instead of the perforated sheet-metal, on account of the greater area of opening in proportion to metal, but for this purpose, to resist the very heavy work imposed on it when used for battery work, it is necessary to make it of tempered steel wire, and we can supply this in any mesh from 4 to 60 made from steel wire of No. 12 to 30. Prices of steel wire, 2/- to 3/- per square foot. The wire gauze or cloth is all coated with anti-rust composition that will avoid the difficulty often complained of that woven wire rusts more quickly than perforated metal.

BAKER'S PATENT PRESSURE BLOWER AND EXHAUSTER.

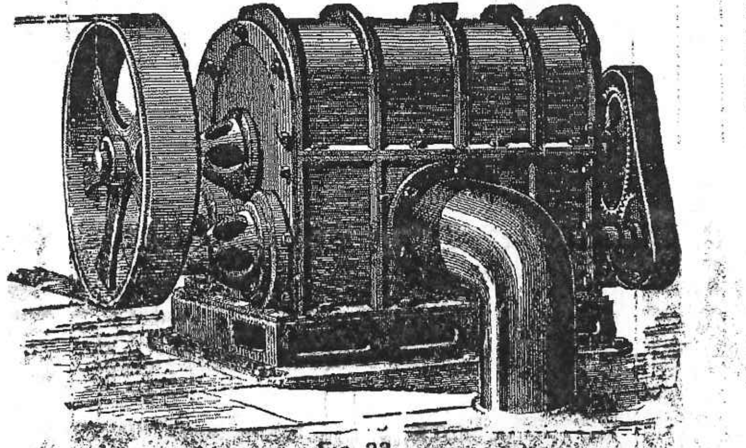

Fig. 33.

These blowers are the best for smelting water jacket furnaces, cupolas, smiths' fires, exhausting, &c., and the attention of engineers is particularly directed to the following advantages:—

First—It is simple and not liable to get out of order, having no sliding vanes or pistons working under pressure internally, and therefore subject to wear and tear.

Second—It passes a very great volume at a low speed, and is consequently low in price.

Third—All the working parts requiring attention and lubrication are external, and can always be inspected and attended to from the outside.

Fourth—The internal arrangements can be seen by removing the top cover without disturbing the inlet and outlet connections on the exhauster.

Fifth—The internal parts not moving in absolute contact, but so close as to be practically tight, the wear and tear is confined to the journals and gear, where ample surfaces are provided, and all of which can be adjusted from the outside, so that the smallest amount of power is required for the work performed.

Sixth—Ample provision is made for drawing off the tar, and its deposition on the inside of the machine cannot in any way injuriously affect its working or efficiency.

Seventh—All shafts are large in diameter, and have adjustable stuffing boxes, whilst the revolving drums are carefully balanced and capable of adjustment from the outside. All material and workmanship are of the best quality. No internal examination is ever needed, unless arising from gross carelessness.

The gear is carefully protected, and improved lubricators are provided for each bearing, every precaution and appliance being used to make these machines thoroughly reliable, durable, and effective.

PRICE LIST OF BLOWERS AND EXHAUSTERS.

CODE WORD	... ...	Ash	Bud	Cocoa	Drug	Elms	Fir	Grape	Hazel	Ilex	Jam
	Displacement of air per revolution ... ... cub. ft.	1½	3	6	9	13	17	25	30	45	60
	Revolutions per minute	250	240	200	175	165	150	140	130	130	130
	Horse power required...	1¾	2½	3½	4	4½	6	8	10	14	20
	Internal diameter of cupola, inches		18	22	27	30	34	40	48	50	52
	Approximate weight of iron melted per hour ... ... tons	—	1	2	2½	3	5	8	10	14	20
	Number of smiths' fires that can be blown	3	7	12	18	24	30	40	50	70	100
Ape	Price of blower, with one pulley ...	£25	£36	£52	£59	£68	£72	£95	£111	£177	£265
Bat	Ditto, with vertical engine	£56	£76	£108	£116	£143	£164	£194	£243	£346	£440
Chick	Price of exhauster, with one pulley	£28	£39	£56	£62	£72	£79	£102	£119	£200	£290
Dove	Ditto, with vertical engine	£53	£73	£104	£113	£139	£157	£187	£235	£323	£415
Ewes	Price of loose pulley and outer bearing	£1 5	£1 15	£3 5	£3 10	£4	£4 5	£5 5	£5 15	£7 15	£9 15

Packing in close cases for shipment, 2½ per cent. extra.

Mercury gauges for indicating the actual pressure in the mains, fitted in neat case, 10/- each. Blowers for blowing smiths' fires should be fitted with an escape valve. When blowers or exhausters are required to pass heated air or gases above 212° F., they should be fitted with water bearings to keep the same cool, at a small extra cost.

Blowers or exhausters are supplied with their outlets on the side shown in the engraving, Figure 33, unless ordered on the opposite side, the inlet being on the opposite side to the outlet; but, if desired, the inlet can be placed at the bottom.

The blowers and exhausters, when fitted with their own engines, can, of course, be more easily regulated to the work than if driven from a shaft having a fixed regular speed, and the engines can be fitted with an automatic governor to maintain a constant pressure in the mains, and thus suiting the speed and supply of air to any irregular demand; this will be charged extra if fitted.

ALL-ROUND STEEL TIP WAGGON.

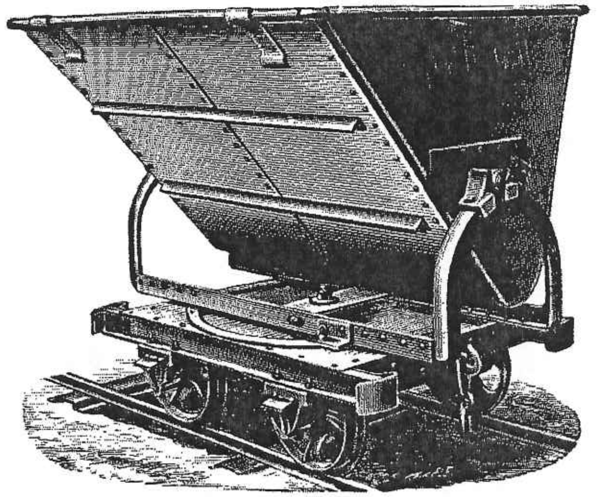

FIG. 42.

In mining, and many other operations, a waggon that can discharge or tip on either side or end, like that shown in our engraving, Figure 42, will often save much labour, and the cost and loss of time involved by the use of turntables.

The under-frame carrying the body is fitted with a swivelling arrangement that enables the body to be easily turned to either side or end and then tipped, a pin holding the body fixed when travelling; the whole is of steel, and can be supplied to any gauge from 16 in. to 36 in., in three sizes, at the undermentioned prices:—

CODE WORD	... ...	Ash	Bud	Cocoa
	Capacity ... ... cub. ft.	15	20	30
	Diameter of wheels ... ... inches	10	12	14
Ape	Price as engraving	£10 10	£12	£16
Bat	Extra price for brake	15/-	£1	£1 5
Chick	„ „ spring axle boxes	10/-	15/-	£1

In addition to the waggons, Figures 41 and 42, we supply slag cars; copper mould trucks; bullion waggons, on plain or flanged wheels; amalgam waggons; drop-bottom hot-ore trucks for taking the charges from the roasting furnaces to the cooling floor, or for feeding the chlorination plant. The prices, capacity for capacity, are the same for the latter as quoted above for the all-round tip waggons.

STEEL MINING WAGGON.

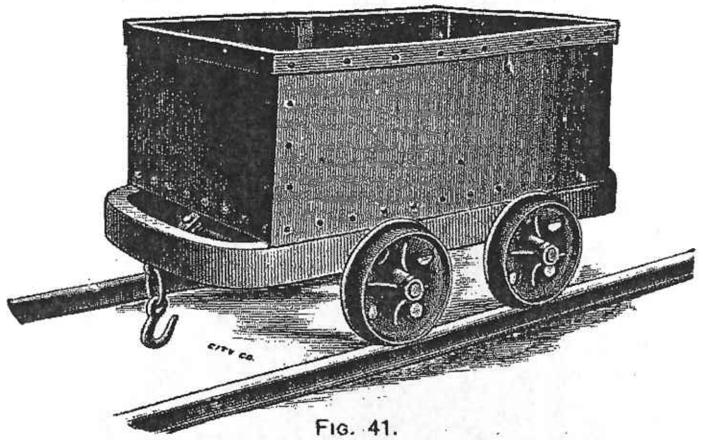

FIG. 41.

The above waggon is constructed entirely of steel for carrying all kinds of minerals, the body is of $\frac{3}{16}$in. plates stiffened by a flat bar rivetted to the top edge, the under-frame of channel section, curved at the ends to form central buffers, the wheels and axles are of steel, and the axle boxes fitted with gun-metal bearings, with oil well for lubricating the bearings. They are made of three sizes as shown in the following list, of any gauge from 16 in. to 36 in.; required gauge should be stated in ordering.

CODE WORD	... ...	Ash	Bud	Cocoa
	Capacity ... ... cub. ft.	15	20	27
	Diameter of wheels ... ... inches	10	12	14
Ape	Price of waggon, Figure 41	£7 10	£10 10	£13 10
Bat	Extra price if fitted with brake	15/-	£1	£1 5
Chick	„ „ „ spring axle boxes ...	10/-	15/-	£1

Suitable tramway lines for the above of 12 lbs. per yard steel rails, can be supplied for 16 in. to 30 in. gauge at £285 to £320 per mile; rails of 16 lbs. per yard at £385 to £420, according to gauge; rails of 20 lbs. per yard of 20 in. to 36 in. gauge, £560 to £605 per mile; cast-iron turntables, £5 10s. to £8 10s. each; wrought-iron turntables, £15 to £40 each; left or right-hand crossings, £5 to £7 per set; left or right-hand two-way crossings, £5 10s. to £11 per set; left or right-hand three-way crossings, £7 10s. to £20 per set; wooden side or end tip waggons, 15 cubic feet, £7 each; wooden side or end tip waggons, 20 cubic feet, £8 each; wooden side or end tip waggons, 30 cubic feet, £11 10s. If complete set ironwork *only* is supplied, including steel wheels and axles, one half the above prices.

BORNHART'S PATENT ELECTRICAL FIRING MACHINES.

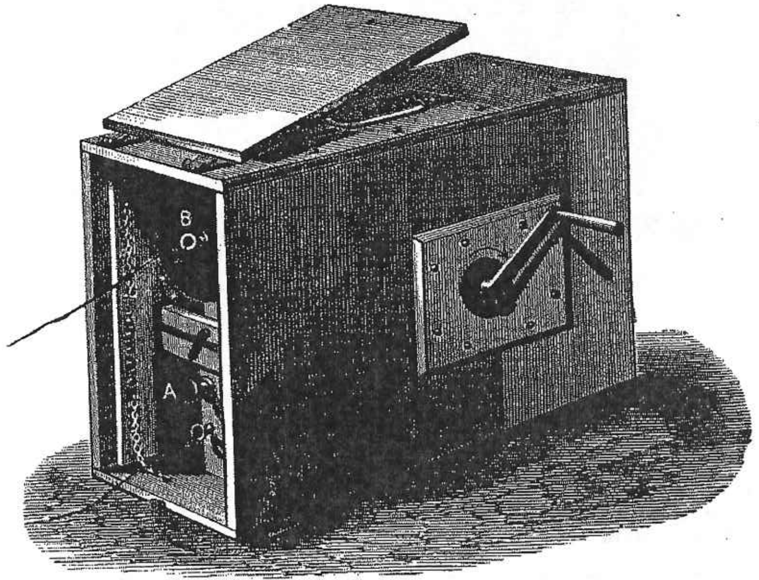

FIG. 34.

The advantages of electric blasting over the old system of blasting with safety fuse are so many and so evident, as to render it a matter of surprise that electric blasting has not become more general in this country. On the continent of Europe and in America it has long been in use, giving the best results both in safety and economy. By using electricity as the firing agent and exploding a number of shots simultaneously, it is found that a greatly-increased amount of work is done and a great saving in cost effected. Indeed, in some cases twice the amount of work has been done in a given time, with a saving of one-fifth in the amount of explosive employed. By the simultaneous ignition of the charges the whole force of the explosive is developed at the same instant, and, being brought to bear on the entire mass to be rended, a much greater effect is produced than would be the case if the holes were fired independently, each hole having to shift its own burden without any assistance from the others. It is found in practice that the same work can be done with a much less number of holes where electric blasting is employed, than would be required if the charges were fired singly.

In close levels and shafts, where the ventilation is defective, it is nothing unusual for the workmen to wait half-an-hour or more after each blast, to allow the smoke and fumes to clear away, and as several blasts are usually made in the twenty-four hours, a great deal of time is thus lost. In electric blasting this loss is reduced to a minimum, since only one blast is made instead of several. In the case of miss-fires or "hang-fires" the gain is still more evident, since, if the charges are not simultaneously exploded, they cannot by any possibility explode at all, and there can be no danger in approaching the face at once to discover the cause.

In submarine work and in wet shafts, where the charges have to be fired under water, electric blasting is indispensable, since, if the insulation of the wires be properly attended to, the charges are fired after being immersed for hours with the same certainty as in dry places; moreover, it is possible to remove everything to a place of safety, leisurely and carefully, before exploding the charges.

In quarry work electric blasting is found highly advantageous, saving much time and labour. By a proper arrangement of cables or leading wires and employing suitable machines, the whole of the charges in a quarry may be exploded in a few minutes, instead of, as in many cases with the present system, stopping the quarrying work for hours during the day.

This system is also being extensively employed with great advantage in quarrying and splitting blocks of stone for monumental and building purposes. A row of holes being bored and fired simultaneously, will split the stone in the required line of fracture with great certainty.

PRICES OF MACHINES, FUSES, CABLES, &c.

CODE WORD	... ...					Ash
		Length.	Width.	Height.	Weight.	PRICE.
Ape	No. 1, or single-plate electric machine	20 in.	7½ in.	15¾ in.	30 lbs.	£8 15
Bat	No. 2, or double-plate electric machine	21¾ in.	11 in.	16 in.	47 lbs.	£12 12

PRICES OF ELECTRIC FUSES with Insulated Copper Wires, at per 100.

CODE WORD	... ...	Bud	Cocoa	Drug	Elms	Grape	Hazel	Ilex	Jam
	Length of wires, inches	12	20	24	32	36	40	50	60
Chick	Single force detonators	11/9	14/9	16/3	19/3	20/9	22/3	26/-	29/9
Dove	Double ditto	13/-	16/-	17/6	20/6	22/-	23/6	27/3	33/-
Ewes	Treble ditto	13/9	16/9	18/3	21/3	22/9	25/6	28/-	31/9

Any other length of wires at proportionate prices.

PRICES OF CABLES.

CODE-WORD	... ...	Kernel
Fox	Cable, containing two insulated conductors, each composed of three strands of tinned copper wire, covered with india-rubber and tape, stranded together and covered with india-rubber and tape, and an outer covering of braided and tarred hemp ... ... per 100 yds.	£5
Goats	Iron sheathed cable, containing one insulated conductor, composed of a strand of three copper wires, insulated with two coverings of gutta-percha, or indiarubber and tape, and sheathed on the outside with a covering of twelve galvanized-iron wires ... ... per 100 yds.	£6
Heron	Small copper wire, for connections, insulated with gutta-percha ... ... per 100 yds.	8 4
Ibis	Ditto ditto ditto per 1,760 yds.	£6 10
Jay	Large ditto, for connecting ends of cable wires to machine, and to a point near to the shot holes ... ... per 100 yds.	£1 5
Kraken	Ditto ditto ditto per 1,760 yds.	£20 10
Locust	Insulators, for attaching to wood supports for carrying small wires ... ... per doz.	6

The fullest instructions and directions will be sent with each set of apparatus, enabling anyone to introduce and use this system of blasting.

A REVOLUTION IN QUARTZ-CRUSHING MACHINERY.

(From *The Mining World and Engineering Record*, Oct. 6, 1888.)

A problem, which has long occupied the attention of persons connected with mining, is how to supersede stamps in countries where transport is difficult. The solution, it is now alleged, has been found in "The Huntington Centrifugal Roller Quartz Mill," the agents for which, in London, are Messrs. Calvert, Cornes and Harris, of 30, Walbrook,—the sole licencees and manufacturers for all countries, excepting the United States and Australia, being the well-known engineering firm of Messrs. Davey, Paxman and Co., of Colchester. It was to the works of this firm that a select party of gentlemen repaired on Monday last, with the object of seeing the Huntington mill in actual operation.

The mill in question has been made by Messrs. Davey, Paxman and Co., under the direction of Messrs. Calvert, Cornes and Co., for the Essaman Company, which it is scarcely necessary to inform our readers is mining with much success on the Gold Coast, under the experienced direction of that veteran miner, Mr. C. J. Harvey. The chief difficulty the Company has had to surmount has been that of transport from the port at Axim to the mines, and, therefore, when a knowledge of the Huntington mill was brought to the managing director, Mr. Henry Tolputt, he at once, in conjunction with Mr. Harvey, saw it was exactly what was wanted for Africa. In addition to its greater portability, the reduced cost of construction, as compared with mills of the ordinary kind, was

naturally an element that had considerable weight. In passing, we may state that the appliances already on the ground include twelve heads of gravitation stamps, another twelve heads being on the way up the river. These were manufactured specially under the direction of Messrs. Calvert, Cornes and Co., with all recent improvements in reduction machinery as designed by Mr. Harvey. In the course of driving a long length of reef, three miles in extent, returns of gold have already been made to the extent of about £3,000 in all; and it has become obvious to the management that they must be provided with additional power to utilize the resources of this valuable property when sufficient stoping ground has been laid open. Considering that the Company has only been actually at work twelve months, and has had all its preliminary operations to accomplish in that period, it must be judged that this return is highly encouraging, especially when it is remembered that no stoping work has as yet been done, and when the fact is also taken into consideration that regular crushings may shortly be expected. We may incidentally mention that the authorized capital of this Company is but £50,000, and a very moderate amount of success will yield a handsome return on so small a capital.

The Huntington mill, which, as supplied to the Essaman Company, will be driven by a 10 H.-P. engine, presents some new features interesting to all connected with gold mines. It has been largely used in the United States and Mexico, and is rapidly commanding the attention of the mining community. The advantages claimed for the mill by the makers are the following:—(1.) The cost of same capacity is not more than one-half that of stamps. (2.) Freight to mine one-fourth that of stamps. (3.) Cost of erection at mine one-tenth that of stamps. (4.) It runs with one-third the power per ton of ore crushed. (5.) The wear is less than that of stamps. (6.) The wearing parts are easily duplicated. (7.) It has a much better discharge, and leaves the pulp in better condition for concentrating. (8.) It is a better amalgamator, saving fully nine-tenths of the gold in the mill (the balance can be saved on plates in the usual manner). (9.) Its simplicity of construction obviates the need of mechanical skill. (10.) It is continually crushing, not like the stamp, using power to suspend it in air ninety-nine one-hundredths of the time, and the balance, making a thundering noise and accomplishing comparatively small results. It is as far in advance of the stamp mill as the present method of making flour with improved rolls is over the Indians' mode of crushing corn in a stone mortar. As employed at the Broomassie section of the Essaman's Company's property, where it is proposed to erect it in the first instance, the *modus operandi* will be as follows:—The quartz will first be crushed by a Blake-Marsden stone-crusher, and then, by a self-feeding arrangement, be delivered into the Huntington mill. The rotating rollers and scrapers throw the ore against the ring-die, where it is crushed to any desired fineness by the centrifugal force of the rollers as they roll over it. The water and pulverized ore are thrown against and through the screens when fine enough. The discharge makes little or no slimes, and leaves the pulp in good condition for concentration. The rollers are suspended, leaving a space of 1 in. between them and the bottom of the mill, thus allowing them to pass freely over the quicksilver and amalgam without grinding it and throwing it from the mill, while it agitates it sufficiently to secure amalgamation. The mill has been spoken of very highly by Mr. C. A. Moreing, C.E., of the eminent firm of Bewick and Moreing, and one of its patrons is Mr. E. Probert, of the Richmond Mine, a gentleman who, certainly in matters of machinery, will be admitted to know what he is about; and another is the Nine Reefs Company in India. The introduction of mercury into the mill saves a large quantity of fine gold in that way, which is readily taken up without passing through the screens. The ore passing through the screens is dealt with on the amalgamating tables in the ordinary way. The mill has been greatly improved by the combined ingenuity of Messrs. Calvert and Cornes, Mr. Paxman, and Mr. C. J. Harvey, so that now, in the opinion of practical men, it may fairly claim to be the best substitute for stamps that has yet been introduced. It is said that the 5-ft. mill—that is, 5 ft. in diameter—will do the work of ten heads of stamps, but should it only succeed in treating 15 tons of quartz per day, instead of 20, as alleged, it will, undoubtedly prove a great success. Of course, much will depend upon the character of the quartz, and further experience gained in working. The mill certainly seems specially adapted for Gold Coast mines, and those of South Africa generally, where machinery has to be transported under circumstances of difficulty and expense, as it can be conveyed into the interior by bullock team. No portion weighs more than ½ ton, and the heavier parts can, if necessary, be still further subdivided.

For prospecting purposes a mill of this description seems highly desirable. It is made in two sizes—one of 5 ft., like the one inspected on Monday, and the other of 3½ ft. The latter may be taken up the country on the backs of mules. In this way the value of reefs may be tested before any large outlay is incurred. The use of a mill of this kind would, it seems to us, reduce very considerably the number of mining failures, of which we hear so much, and of the real causes of which we hear so little. Some Companies erect a vast quantity of machinery, and discover their mines to be practically valueless, and others, ascertaining their mines to be valuable afterwards, make the unpleasant discovery that months must elapse before their machinery can be ordered, or that they have sent to them that which is utterly unsuited to the purposes for which it was intended. Now, the employment of the smaller mill in the cases of untested mines, and of the larger size when the value of reefs has been ascertained beyond doubt, is the "open-sesame" to many a mining problem that at present baffles and disturbs the calculations of shareholders. From all the information we have been able to gather, the Essaman Company has done a wise thing in deciding to give the Huntington mill a trial on its mine, which it has passed through so satisfactorily in Mexico, the United States, and Queensland. We await the result with confident expectation. Messrs. Calvert, Cornes and Co. have given special attention to the manufacture of quartz crushing and reduction machinery, and we understand that the mills supplied by them to the Essaman and other Companies have given unqualified satisfaction.

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